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CATALOG OF THE TYPE SPECIMENS OF FOSSILS IN THE UNIVERSITY OF CINCINNATI MUSEUM

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INTRODUCTION

The accompanying catalog of type specimens of fossils follows the form set up by Dr. Charles Schuchert and his associates in the Catalogue of Type Specimens of Fossils, Minerals, Rocks, and Ores in the United States National Museum.[1]

It lists alphabetically all Holotypes, Paratypes, Cotypes, subsequently figured specimens, and Plastotypes in the fossil collection of the University of Cincinnati Museum. For each entry is given the catalog number, the name of the species, the author's name, the number of specimens if more than one, the kind of type, the formation, the locality, author and place of publication, and a cross reference if the species appears in the list more than once. In a few cases in which a species is not as yet published, the prefix "Chiro" is added to the kind of type.

For discussion and definition of the kinds of type material the reader is referred to Dr. Schuchert's work cited above, and to the catalog of types published by the Ohio State University Geological Museum in 1924.[1]

In the latter, Dr. Morningstar gives good condensed definitions of the various grades of types, as follows:

"PRIMARY TYPES OR PROTEROTYPES"

"*Holotype*—A single specimen selected from the original material as the type of a species, or a single specimen upon which a species is based is known as the holotype."

[1]Schuchert, U. S. Nat. Mus., Bull. 53, pt. 1, 1905.
[2]Morningstar, Ohio Jour. Sci., Vol. 24, No. 1, Jan. 1924.

"*Paratype*—If a holotype has been selected, but if other specimens are also mentioned, described, figured, or in any way aid in the original description, the latter are called paratypes. A species may therefore have both holotype and one or more paratypes."

"*Cotypes*—If no holotype is selected from the original material, and if two or more specimens are used in describing and figuring a species, these types are known as cotypes."

"*Chirotype*—Chirotype is the term applied to material described in manuscript form. After the manuscript has been published the chirotype will become either a holotype, paratype, etc."

"SECONDARY OR SUPPLEMENTARY TYPES"

"*Plesiotype*—A specimen from any locality which is compared with a species already established, and which is described and figured as such, is called a plesiotype."

"ARTIFICIAL MODELS"

"*Plastotype*—An artificial cast or model made directly from a primary type is called a plastotype."

"FIGURED SPECIMENS"

"A number of specimens are included which cannot be classed as real types, but which have been figured, as for example, Amphibian Coprolites, Fish Spine, etc.; likewise in the same class comes all figured material to which no specific name has been assigned, as Cythere? sp., Palaeoniscus sp., etc. Such entries are marked figured."

In the University of Cincinnati Museum gummed dots are used to designate type specimens; red dots for Holotypes, Cotypes, and Paratypes, and green dots for others.

Most of the types in the collection are from the collection of S. A. Miller, which came to the University of Cincinnati by purchase in 1917, twenty years after his death. Due largely to the condition in which the collection was received there is doubt regarding a few of the specimens marked by Miller as types. In the cases in which the illustrations could not be matched beyond doubt by the specimens, or in which the specific name given could not be found in the literature, the fact is indicated by a question mark after the type-designation, or by a note under the reference.

The catalog contains 2470 specimens distributed as follows:
Holotypes, 180.
Cotypes, 1593.
Paratypes, 557.
Plesiotypes and figured specimens, 140.

2243. *Acidaspis bucheri* Ulrich (Ms.) Chiro-holotype
Maysville-Corryville (Ord.). Cincinnati, Ohio.

4013. *Actinocrinus albersi* Miller and Gurley Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 46, pl. 2, figs. 21–23, 1895.

2227. *Actinocrinus blairi* Miller 3 Cotypes
(=*Cactocrinus glans* (Hall))
Burling group (Miss.). Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 285, pl. 5, figs. 27–29, 1894. Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 35, pl. 5, figs. 27–29, 1892.

2228. *Actinocrinus foveatus* Miller and Gurley 3 Cotypes
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 49, pl. 2, figs. 25–26, 1895.

2229. *Actinocrinus jessieae* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 30, pl. 2, figs. 15–16, 1896.

2229a. *Actinocrinus jessieae* Miller and Gurley 3 Paratypes
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 30, pl. 2, figs. 15–16, 1896.

2230. *Actinocrinus nodosus* Miller Holotype
(=*Cactocrinus thalia* Hall)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, pl. 5, fig. 7, 1891.

2226. *Actinocrinus pettisensis* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 6, pl. 1, figs. 3–4, 1896.

2226a. *Actinocrinus pettisensis* Miller and Gurley 67 Paratypes
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 6, pl. 1, figs. 3–4, 1896.

4010. *Actinocrinus senectus* Miller and Gurley Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 36, pl. 2, figs. 23–25, 1897.

2233. *Actinocrinus spectabilis* Miller and Gurley Holotype
Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 9, pl. 3, fig. 3, 1896.

1963. *Actinostroma irregulare* Fenton — Holotype
Hamilton group (Dev.). Nora Formation.

2249. *Actinostroma rockfordense* Fenton — 4 Cotypes
Nora formation. Rockford, Illinois.

2232. *Agaricocrinus adamsensis* Miller and Gurley — Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 9, p. 24, pl. 1, figs. 7–9, 1896.

2232a. *Agaricocrinus adamsensis* Miller and Gurley — Paratype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 9, p. 24, pl. 1, figs. 7–9, 1896.

3343. *Agaricocrinus illinoisensis* Miller and Gurley — Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 25, pl. 1, figs. 21–23, 1896.

3343a. *Agaricocrinus illinoiensis* Miller — 1 Paratype
Burlington group. Adams County, Illinois.
Bull. No. 8, Ill. State Mus. Nat. Hist., p. 25, pl. 1, figs. 21–23, 1896.

3367. *Agaricocrinus splendens* Miller and Gurley — Holotype
Keokuk group (Miss.). Crawfordsville, Indiana.
Miller and Gurley, Jour. Cincinnati Soc. Nat. Hist., Vol. 13, p. 18, pl. 4, fig. 12, 1890. 16th Rep. Dept. Geol. Nat. Res. Ind., p. 340, pl. 4, figs. 1–2, 1890. Not in 17th report.

3366. *Agaricocrinus splendens* Miller and Gurley — Paratype
Keokuk group (Miss.). Crawfordsville, Indiana.
Miller and Gurley, Jour. Cincinnati Soc. Nat. Hist., Vol. 13, p. 18, 1890.

3793. *Ambonychia cincinnatiensis* Miller and Faber — Cotype
(=*Byssonychia vera* Ulrich)
Eden (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 24, pl. 1, figs. 8–10, 1894.

3794. *Ambonychia cincinnatiensis* Miller and Faber — 8 Cotypes (?)
(=*Byssonychia vera* Ulrich)
Eden (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 24, pl. 1, figs. 8–10, 1894.

3787. *Ambonychia robusta* Miller (Part) — 2 Cotypes
(=*Byssonychia richmondensis* Ulrich)
Richmond-Whitewater (Ord.). Richmond, etc., Indiana.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 3, p. 315, 1880.

3866. *Amphoracrinus blairi* Miller and Gurley — Cotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 26, pl. 1, figs. 45–50, 1896.

4005. *Amphorocrinus jessieae* Miller and Gurley — Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 21, pl. 3, figs. 18–19, 1896.

1394. *Amplexus bicostatus* Miller Holotype and 4 Paratypes
2237. (See *Amplexus fragilis* White and St. John)
2237a. Burlington group (Miss.). Sedalia, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 618, pl. 1, fig. 10, 1892. Miller, Adv. Sheets 17th Rep. Dept. Geol. Nat. Res. Ind., p. 8, pl. 1, fig. 10, 1891.

3918. *Amplexus blairi* Miller 3 Cotypes
3919. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets 17th Rep. Dept. Geol. Nat. Res. Ind., p. 8, pl. 1, fig. 7, 1891.

2238. *Amplexus corniculum* Miller Holotype and 48 Paratypes
2238a. Chouteau limestone (Miss.). Pettis, County, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 9, pl. 1, figs. 21–22, 1891.

1394. *Amplexus fragilis* White and St. John
Holotype and 4 Paratypes
2237. (=*Amplexus bicostatus* Miller)
2237a. Burlington group (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 8, pl. 1, fig. 10, 1892. Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 8, pl. 1, fig. 10, 1892. White and St. John, Trans. Chicago Acad. Sci., Vol. 1, p. 116, 1868.

3789. *Arthropora shafferi* (Meek) 4 Cotypes
(See *Ptilodictya* (*Stictopora*) *shafferi* Meek)
Maysville–(Bellevue, Corryville) (Ord.). Cincinnati, Ohio.
Meek, Proc. Acad. Nat. Sci. Philadelphia, p. 317, Ohio Pal., Vol. 1, p. 69, pl. 5, figs. 1a-c, 1873.

4512. *Asidopora eccentrica* (James) Plesiotype
Eden (Southgate) (Ord.). Cincinnati, Ohio.
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 30, fig. 16, 1934.

4519. *Atactoporella ortoni* (Nicholson) Plesiotype
Maysville (Bellevue) (Ord.). Clover Creek, Cincinnati, Ohio.
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 29, fig. 7, 1934.

3868. *Athyris brittsi* Miller Holotype
Devonian. North Otterville, 17 mi. w. of Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 314, pl. 9, figs. 16–18, 1893.

2242. *Athyris chouteauensis* Miller 100 Cotypes (?)
(Marked types in Miller Collection)
Chouteau limestone (Miss.). Cooper County, Missouri.

3872.
3873. *Athyris ottervillensis* Miller 11 Cotypes
Devonian. Nr. Otterville, 17 mi. w. of Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 314, pl. 9, figs. 14–15, 1893.

511– *Atrypa corrugata* Fenton and Fenton
513. Holotype and 5 Paratypes
Traverse (Dev.). No. 23, Rose Quarry, Near Bay Shore, Michigan.
Fenton and Fenton, Am. Mid. Nat., Vol. 12, p. 5, pl. 1, figs. 10–13, 1930.

561–563. *Atrypa dignata* Fenton and Fenton
Holotype and 2 Paratypes
Traverse (Dev.). No. 22, Rose Quarry, Near Bay Shore, Michigan.
Fenton and Fenton, Am. Mid. Nat., Vol. 12, p. 11, pl. 2, figs. 10–11, 1930.

594–596. *Atrypa littletonensis* Fenton and Fenton
Holotype and 2 Paratypes
Cedar Valley (Dev.).-Littleton, No. 5, Littleton Section. Littleton, Iowa.
Fenton and Fenton, Am. Mid. Nat., Vol. 12, p. 13, pl. 2, figs. 3–4, 1930.

3968. *Atrypa missouriensis* Miller 5 Cotypes
3970. Devonian. Near Otterville, 17 mi. w. of Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 315, pl. 9, figs. 19–21, 1893.

570–577. *Atrypa petosequa* Fenton and Fenton
Holotype and 7 Paratypes
Traverse (Dev.). No. 23, Rose Quarry, Near Bay Shore, Michigan.
Fenton and Fenton, Am. Mid. Nat., Vol. 12, p. 7, pl. 1, figs. 1–8, 1930.

566–568. *Atrypa petosequa lata* Fenton and Fenton
Holotype and 2 Paratypes
Traverse (Dev.). No. 23, Rose Quarry, Near Bay Shore Michigan.
Fenton and Fenton, Am. Mid. Nat., Vol. 12, p. 9, pl. 1, fig. 9, 1930.

580–583. *Atrypa traversensis* Fenton and Fenton
Holotype and 3 Paratypes
Traverse (Dev.). No. 1, Quarry, Mud Lake, E. of Kegomic, Michigan.
Fenton and Fenton, Am. Mid. Nat., Vol. 12, p. 6, pl. 2, figs. 12–14, 1930.

2036– *Aulopora confluens* Fenton 6 Paratypes
2038. Hackberry—Cerro Gordo, Pugnoides zonule (Dev.). Bird Hill, near Rockford, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 380, pl. 2, figs. 5–7, 1927.

2022– *Aulopora cerebriformis* Fenton Holotype and 2 Paratypes
2024. Shellrock—Lepidocentrus zone—Camarophoria zonule (Dev.). Nora Springs, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 377, pl. 2, figs. 17–18, 1927.

2033. *Aulopora delicata* Fenton Holotype
Hackberry—Cerro Gordo Substage—Heliophyllum zonule (?) (Dev.). 1 mi. N. W. of Juniper Hill, near Rockford, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 381, pl. 1, figs. 2–4, 1927.

2028. *Aulopora irregularis* Fenton Holotype and Allotype
2029. Shellrock—Aulopora zone—Pachyphyllum zonule (Dev.). Nora Springs, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 376, pl. 2, figs. 11–12, 1927.

2040. *Aulopora linearis* Fenton Paratype
Shellrock—Aulopora zone—Alveolites zonule (Dev.). Parker's Mill, Mason City, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 378, pl. 2, fig. 16, 1927.

2041. *Aulopora linearis* Fenton Holotype (Part)
Shellrock—Lepidocentrus zone—Camarophoria zonule (Dev.). Nora Springs, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 379, pl. 1, fig. 10, 1927.

1409. *Aulopora michiganensis* Fenton Holotype
Traverse. No. 22, Rose Quarry, 6 mi. W. of Petoskey, Michigan.

1410. *Aulopora michiganensis* Fenton 2 Paratypes
Traverse. No. 22, Rose Quarry, 6 mi. W. of Petoskey, Michigan.

2034. *Aulopora modulata* Fenton 2 Paratypes
2035. Shellrock—Shizophoria zone (Dev.). Flood Cr., 4 mi. E. of Rockford, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 375, pl. 1, figs. 5–9, 1927.

2031. *Aulopora munda* Fenton Holotype and Paratype
2032. Shellrock—Aulopora zone—Pachyphyllum zonule (Dev.). Nora Springs, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 377, pl. 2, figs. 12–14, 1927.

2025– *Aulopora noraensis* Fenton Holotype and 6 Paratypes
2027. Shellrock — Aulopora zone — Pachyphyllum (Dev.). Nora
2039. Springs, Iowa.
M. A. Fenton, Am. Mid. Nat., Vol. 10, p. 375, pl. 1, fig. 5, pl. 2, figs. 8–10, 1927.

3894. *Aviculopecten sculptilis* Miller Holotype
Pennsylvanian. Kansas City, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 702, pl. 20, fig. 5, 1892. Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 92, pl. 20, fig. 5, 1891.

3815. *Batocrinus* (abnormal) Miller and Gurley Figured specimen
Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 64, pl. 4, figs. 24–25, 1896.

3825. *Batocrinus adamsensis* Miller and Gurley Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 14, pl. 1, figs. 33–35, 1896.

3816. *Batocrinus approximatus* Miller and Gurley 2 Cotypes
Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 56, pl. 4, figs. 10–12, 1896.

3836. *Batocrinus argutus* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 9, pl. 1, figs. 8–9, 1896.

3826. *Batocrinus asper* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 13, pl. 1, figs. 15–16, 1896.

3828. *Batocrinus asperatus* Miller and Gurley Holotype
Burlington group (Miss.). Adams County, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 12, pl. 1, figs. 13–14, 1896.

3829. *Batocrinus basilicus* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 11, pl. 1, figs. 10–12, 1896.

3215. *Batocrinus blairi* Miller Paratype
(=*Eretmocrinus leucosia*)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 39, pl. 6, figs. 7–10, 1892.

3216. *Batocrinus broadheadi* Miller and Gurley
3216a. Holotype and Paratype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 15, pl. 1, figs. 10–11, 1895.

3835. *Batocrinus cognatus* Miller and Gurley Cotype
Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 60, pl. 4, fig. 20, 1896.

3219. *Batocrinus divalis* Miller 13 Cotypes
3219a. (=*Dizygocrinus unionensis* var. *divalis* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 22, pl. 3, figs. 6–7, 1892.

2189. *Batocrinus douglassi* Miller and Gurley
2189a. Holotype and 14 Paratypes.
Burlington group (Miss.). Bozeman, Montana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 29, pl. 2, fig. 26, 1897.

3218. *Batocrinus enodis* Miller and Gurley Holotype and Paratype
3218a. Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 25, pl. 1, figs. 16–18, 1896.

3865. *Batocrinus folliculus* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.

Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 15, pl. 1, figs. 36–38, 1896.

3221. *Batocrinus formaceus* Miller and Gurley
3221a. Holotype and 3 Paratypes
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 24, pl. 1, figs. 23–24, 1895.

3837. *Batocrinus germanus* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 5, pl. 1, figs. 1–3, 1896.

3223. *Batocrinus heteroclitus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 31, pl. 1, figs. 37–39, 1895.

3823. *Batocrinus hodgsoni* Miller and Gurley Holotype
Burlington group (Miss.). Marblehead, Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 8, pl. 1, figs. 6–7, 1896.

3225. *Batocrinus ignotus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 28, pl. 1, figs. 31–33, 1895.

3226. *Batocrinus imparalis* Miller and Gurley
3226a. Holotype and 23 Paratypes
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 20, pl. 1, figs. 17–18, 1895.

3227. *Batocrinus inconsuetus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 25, pl. 1, figs. 25–27, 1895.

3228. *Batocrinus incultus* Miller and Gurley
3228a. Holotype and 5 Paratypes
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 21, pl. 1, figs. 19–20, 1895.

3822. *Batocrinus inopinatus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missorui.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 36, pl. 2, figs. 4–6, 1895.

3230. *Batocrinus insolens* Miller and Gurley Holotype and Paratype
3230a. Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 35, pl. 2, figs. 1–2, 1896.

3821. *Batocrinus insperatus* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 22, pl. 1, figs. 21–22, 1895.

3827. *Batocrinus insuetus* Miller and Gurley — Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 14, pl. 1, figs. 8–9, 1895.

3231. *Batocrinus jessieae* Miller and Gurley — 3 Cotypes
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 20, pl. 1, figs. 27–32, 1896.

3232. *Batocrinus modestus* Miller and Gurley
3232a. Holotype and 6 Paratypes
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 30, pl. 1, figs. 34–36, 1895.

3824. *Batocrinus modulus* Miller and Gurley — Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 16, pl. 1, figs. 39–41, 1896.

3811. *Batocrinus nanus* Miller and Gurley — Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 17, pl. 1, figs. 42–44, 1896.

3830. *Batocrinus nitidulus* Miller and Gurley — 4 Cotypes
3831. Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 17, pl. 1, figs. 12–13, 1895.

3233. *Batocrinus nodosus* Miller and Gurley — Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 9, p. 5, pl. 1, figs. 1–3, 1896.

3234. *Batocrinus nodulosus* Miller and Gurley — Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 9, p. 6, pl. 1, figs. 4–6, 1896.

3832. *Batocrinus parilis* Miller and Gurley — Cotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 9, p. 17, pl. 2, figs. 1–2, 1896.

3819. *Batocrinus peculiaris* Miller and Gurley — Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 18, pl. 1, figs. 14–16, 1895.

3236. *Batocrinus planus* Miller and Gurley — 3 Cotypes
3236a. Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 37, pl. 2, figs. 11–14, 1895.

3840. *Batocrinus politus* Miller and Gurley — Holotype
Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 31, pl. 1, figs. 23–25, 1896.

3237. *Batocrinus polydactylus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 5, pl. 1, fig. 1, 1895.

3238. *Batocrinus procerus* Miller and Gurley Holotype
Keokuk group. Boonville, Missouri.
Bull. No. 7, Ill. State Mus. Nat. Hist., p. 33, pl. 1, figs. 40–42, 1895.

3820. *Batocrinus proximus* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 7, pl. 1, figs. 4–5, 1896.

3239. *Batocrinus pulchellus* Miller 64 Cotypes
(=*Dizygocrinus unionensis* Worthen)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 68, pl. 11, figs. 13–14, 1891.

3854. *Batocrinus reliquus* Miller and Gurley Holotype
Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 22, pl. 1, figs. 15–17, 1897.

3241. *Batocrinus remotus* Miller and Gurley Holotype and Paratype
3241a. Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 43, pl. 2, figs. 15–17, 1896.

3857. *Batocrinus rotuliformis* Miller and Gurley Holotype
Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 26, pl. 1, figs. 26–27; pl. 2, figs. 1–2, 1897.

3243. *Batocrinus rusticellus* Miller and Gurley
3243a. Holotype and 3 Paratypes
Burlington gtoup (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 23, pl. 1, figs. 18–21, 1897.

3855. *Batocrinus rusticus* Miller and Gurley Holotype
Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 28, pl. 2, figs. 3–6, 1897.

3244. *Batocrinus sampsoni* Miller and Gurley 2 Cotypes
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 7, pl. 1, figs. 2–3, 1895.

3245. *Batocrinus scitulus* Miller and Gurley Holotype and Paratype
3246. Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 19, pl. 1, figs. 10–11, 1897.

3247. *Batocrinus sedaliensis* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 71, pl. 4, figs. 31–32, 1896.

3248. *Batocrinus senex* Miller and Gurley 4 Cotypes
3248a. Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 21, pl. 1, figs. 12–14, 1897.
3249. *Batocrinus serratus* Miller and Gurley
3249a. Holotype and 3 Paratypes
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 27, pl. 1, figs. 28–30, 1895.
3250. *Batocrinus sharonensis* Miller and Gurley
3250a. Holotype? and Paratype?
Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 18, pl. 1, figs. 7–9, 1897.
3251. *Batocrinus solitarius* Miller and Gurley Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 22, pl. 2, figs. 8–11, 1896.
3252. *Batocrinus variabilis* Miller and Gurley 5 Cotypes
3252a–c. Burlington group (Miss.). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 58, pl. 4, figs. 13–17, 1896.
3253. *Batocrinus venustulus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 12, pl. 1, fig. 7, 1895.
868. *Batocrinus venustus* Miller 17 Cotypes
(=*Dizygocrinus euconus* var. *abscissus* Rowley and Hare)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 67, pl. 11, figs. 11–12, 1891.
3255. *Batocrinus veterator* Miller and Gurley Holotype and Paratype
3255a. Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 8, pl. 1, fig. 4, 1895.
3254. *Batocrinus vetustus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 10, pl. 1, figs. 5–6, 1895.
3860. *Batocrinus vicinus* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 34, pl. 2, figs. 1–3, 1895.
3256. *Batocrinus wachsmuthi* White Cotype
Keokuk group. Crawfordsville, Indiana.
12th Rep. U. S. Geol. Surv. Terr., p. 162, pl. 40, figs. 1a-1b, 1880.
3951a. *Bellerophon blairi* Miller and Gurley 13 Cotypes
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11,

p. 21, pl. 3, figs. 7–8, 1896. (Taken from *Bellerophon sedaliensis*—Box 3951).

3949–3951. *Bellerophon sedaliensis* Miller and Gurley 5 Cotypes
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 21, pl. 3, figs. 9–10, 1896.

1322. *Beyrichia hammelli* Miller an Faber 1 slab and Cotypes
(=*Ctenobolbina hammelli* (Miller and Faber))
Richmond (Arnheim-Waynesville) (Ord.). Versailles, Indiana.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 156, pl. 8, fig. 26, 1894. Miller, N. A. Geol. Pal. 2nd App., p. 787, fig. 1458, 1897.

3912–3915. *Blairella sedaliensis* Miller and Gurley 6 Cotypes
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 7, pl. 1, figs. 4–8, 1896.

1955. *Buthotrephis* Fenton Plasto-holotype
Plattin No. 14 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Walker Museum 25952.
C. L. Fenton, Am. Mid. Nat., Vol. 11, p. 126, pl. 1, fig. 4, 1928.

849. *Buthotrephis brachiatus* Fenton Plasto-holotype
Plattin, No. 24 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Walker Museum 25949.
C. L. Fenton, Am. Mid. Nat. Vol. 11, p. 126, pl. 1, figs. 2–3, 1928.

1954. *Buthotrephis brachiatus* Fenton Paratype
Plattin, No. 24 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Walker Museum 25953.

1952. *Buthotrephis regularis* Fenton Plasto-holotype
Plattin, No. 14 (Ord.). S. Beckett Hill, Ste. Geneveive County, Missouri.
Walker Museum 25951.
C. L. Fenton, Am. Mis. Nat. Vol. 11, p. 126, pl. 1, fig. 1, 1928.

3787. *Byssonychia richmondensis* Ulrich 2 Cotypes
(See *Ambonychia robusta* Miller (Part))
Richmond (Whitewater) (Ord.). Richmond, Indiana.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 3, p. 315, 1878. Ulrich, Geol. Surv. Ohio, Vol. 7, p. 632, pl. 45, figs. 3–4, 1893.

3793. *Byssonychia vera* Ulrich Cotype
(See *Ambonychia cincinnatiensis* Miller and Faber) Eden (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 24, pl. 1, figs. 8–10, 1894. Ulrich, Geol. Surv. Ohio, Vol. 7, p. 629, figs. a–c, 1893.

3794. *Byssonychia vera* Ulrich 8 Cotypes ?
(See *Ambonychia cincinnatiensis* Miller and Faber) Eden (Ord.). Cincinnati, Ohio.

Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 24, pl. 1, figs. 8–10, 1894. Ulrich, Geol. Surv. Ohio, Vol. 7, p. 629, figs. a–c, 1893.

1321. *Bythopora dendrina* (James) Holotype
(See *Bythopora fruticosa* Miller and Dyer)
Maysville (Fairmount) (Ord.). Cincinnati, Ohio.
Miller and Dyer, Contr. Pal., No. 2, p. 6, pl. 4, figs. 6–6a, 1878. Miller, N. A. Geol. Pal., p. 295, fig. 461, 1889.

1321. *Bythopora fruticosa* Miller and Dyer Holotype
(See *Bythopora dendrina* (James).)
Maysville-Fairmount. Cincinnati, Ohio.
Contr. Pal., No. 2, p. 6, pl. 4, figs. 6–6a, 1878.
Miller, N. A. Geol. Pal., p. 295, fig. 461, 1889.

2227. *Cactocrinus glans* Hall 3 Cotypes
(See *Actinocrinus blairi* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 35, pl. 5, figs. 27–29, 1892. 18th Rep. Dept. Geol. Nat. Res. Ind., p. 289, pl. 5, figs. 27–29, 1893.

2230. *Cactocrinus thalia* Hall Holotype
(See *Actinocrinus nodosus* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 33, pl. 5, fig. 7, 1891.

1494. *Camarophoria paupera* Belanski Paratype
Camarophoria zonule—Mason city—substage—Shellrock (Dev.). Nora Springs, Iowa.
Belanski, Bull. State Univ. Ia. Stud. Nat. Hist., Vol. 12, No. 7, p. 27, pl. 4, figs. 6–14, 1928. Am. Mid. Nat., Vol. 11, p. 193, pl. 15, figs. 18–26, 1928.

1466. *Camarophoria prolifica* Belanski Paratype
Hackberry—Owen substage (Dev.)., Solenopora zonule. 3 mi. S. of Rockwell, Iowa.
Belanski, Univ. Ia. Stud. Nat. Hist., Vol. 12, No. 7, p. 32, 1928.

3807. *Cancellaria livingstonensis* Miller Holotype
Ripley (Cret.). Livingston, Alabama.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 5, pl. 4, figs. 4–4a, p. 86, 1882.

3804. *Caryocrinites ellipticus* (Miller and Gurley) Cotype
(See *Caryocrinus ellipticus* Miller and Gurley)
Clinton (Osgood) (Sil.). Osgood, Indiana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 5, p. 10, pl. 2, figs. 13–14, 1894.

3804. *Caryocrinus ellipticus* Miller and Gurley Cotype
(=*Caryocrinites ellipticus* (Miller and Gurley))
Clinton (Osgood) (Sil.). Osgood, Indiana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 5, p. 10, pl. 2, figs. 13–14, 1894.

1460. *Ceraurus pleurexanthemus* Green Plasto-geno-holotype (Restored)
Trenton (Ord.) Trenton Falls, New York.

Greene, Monthly Amer. Jour. Geol., Vol. 1, p. 560, pl. 4, fig. 10, 1832.

3923. *Chaenomya longa* Miller and Gurley — Cotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 8, pl. 1, figs. 12–13, 1896.

3258. *Clidophorus chicagoensis* Miller — 3 Cotypes
Niagara group (Sil.). Chicago, Illinois.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 3, p. 314, pl. 8, figs. 2–2a, 1881.

3967. *Clidophorus faberi* Miller — 13 Cotypes
Richmond (Ord.). Near Versailles, Indiana.
Miller, N. A. Geol. Pal., p. 471, fig. 795, 1889.

3845. *Codaster blairi* Miller and Gurley — Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 86, pl. 5, figs. 20–22, 1895.

3814. *Codaster gratiosus* Miller — Holotype
Keokuk group (Miss.). Near Bloomfield, Missouri.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 2, p. 257, pl. 15, figs. 5–5a, 1880.

3839. *Codaster jessieae* Miller and Gurley — Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 89, pl. 5, figs. 20–22, 1896.

4746–4748. *Collenia columnaris* Fenton and Fenton — Holotype and 2 Paratypes
(Altyn-upper). Near Appekunny Falls, Swift Current Valley, Glacier National Park, Montana.
Fenton and Fenton, Jour. Geol., Vol. 39, p. 682, pl. 1–2, 1931.

4739. *Collenia compacta* Walcott — Plesiotype
Near Swift Current Pass, Glacier National Park, Montana.
Fenton and Fenton, Jour. Geol., Vol. 39, p. 684, pl. 8, fig. 2, 1931. Walcott, Smithsonian Misc. Coll., Vol. 64, p. 112, pl. 15, fig. 7, 1914.

4744. *Collenia ? frequens* Walcott — 2 Plesiotypes
4745. (Siyeh). Near Swift Current Pass, Glacier National Park, Montana.
Fenton and Fenton, Jour. Geol., Vol. 39, p. 685, pl. 8, fig. 1, 1931. Walcott, Smithsonian Misc. Coll., Vol. 64, p. 113, pl. 10, fig. 3, 1914.

7626. *Collenia symmetrica* Fenton and Fenton — Paratype
(Lower siyeh). East Bank Pass.
Fenton and Fenton, Jour. Geol., Vol. 39, p. 683, pls. 3–5, 1931.

4740. *Collenia undosa* Walcott — 2 Plesiotypes
4742. (Sheppard). Garden Wall, above Grinnell Glacier, Glacier National Park, Montana.
Fenton and Fenton, Jour. Geol., Vol. 39, p. 684, pl. 6; pl. 7, figs. 3–5, 1931. Walcott, Smithsonian Misc. Coll., Vol. 64, p. 113, pl. 13, figs. 1–2; pl. 14, figs. 1–2, 1914.

3039. *Collettosaurus missouriensis* (Butts) Topotype
(See *Notalacerta missouriensis* Butts)
(Upper Coal Measure). Kansas City, Missouri.
Charles W. Gilmore, Smithsonian Misc. Coll., Vol. 80, No. 3, p. 58, fig. 30, 1927. Butts, Kansas City Sci., Vol. 5, No. 2, p. 18, 1891.

1964. *Columnaria halli* Nicholson 2 Plesiotypes
1965. Plattin, No. 24 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
C. L. Fenton, Am. Mis. Nat., Vol. 11, p. 128, pl. 2, figs. 1–2, 1928.

3984– *Conularia blairi* Miller and Gurley 3 Cotypes
3986. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 3, p. 73, pl. 7, figs. 14–15, 1894.

3801. *Conularia gattingeri* Safford Plasto-holotype
Trenton (Ord.). Nashville, Tennessee.
Safford, Geol. Tenn., p. 289, 1869.

3803. *Conularia roeperi* Miller and Gurley Holotype
(Coal Measures–Penn.) Luzerne County, Pennsylvania.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 26, pl. 3, figs. 1–2, 1896.

1393. *Conularia sedaliensis* Miller and Gurley 5 Cotypes
1399. Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 28, pl. 3, figs. 4–5, 1896.

3895. *Corydocephalus byrnesanus* (Miller and Gurley) Holotype
(See *Lichas byrnesanus* Miller and Gurley)
Niagaran—(Laurel) (Sil.). Near Madison, Indiana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 3, p. 78, pl. 8, figs. 8–9, 1893.

1504. *Cranaena iowensis* (Calvin) Plesiotype
Cedar Valley (Dev.). Randalia, Iowa.
Belanski, Univ. Ia. Stud. Nat. Hist., Vol. 12, No. 8, p. 8, 1929.

5050. *Cranaena romingeri* (Hall) 3 Plesiotypes
Traverse, No. 22 (Dev.). Rose Quarry, Near Bay Shore, Michigan.
Belanski, Univ. Ia. Stud. Nat. Hist., Vol. 12, No. 8, p. 6, 1929.

3974– *Crania blairi* Miller 4 Cotypes
3976. (See *Crania rowleyi* Gurley)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 56, pl. 9, figs. 5–6, 1892.

1496. *Crania millepunctata Belanski* Paratype
Crania zonule, Rock Grove substage—Shellrock (Dev.). Ulster township, 5 mi. S. E. of Rudd, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, p. 186, pl. 12, figs. 4–6, 1928.

3974– *Crania rowleyi* Gurley 4 Cotypes
3975. (=*Crania blairi* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.

Gurley, New Carb. Foss., Bull. No. 1, p. 3, 1883. Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 56, pl. 9, figs. 5–6, 1892.

1469. *Craspedophyllum iowaensis* Belanski 2 Paratypes
1476. Shellrock stage—Mason City Substage (Dev.). Pachyphyllum zonule. Nora Springs, Iowa, and Quarry near C. M. and St. Paul Depot.

3806. *Cristellaria rotulata?* D'Ozbigny 11 Plesiotypes
Ripley or Upper pt. Rotten limestone. Near Livingston, Alabama.
C. Schlumberger, Jour. Cincinnati Soc. Nat. Hist., Vol. 5, p. 119, pl. 5, figs. 2–2a, 1882.

1322. *Ctenobolbina hammelli* (Miller and Faber) Cotype
(See *Beyrichia hammelli* Miller and Faber)
Richmond (Arnheim — Waynesville) (Ord.). Versailles, Indiana.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 156, pl. 8, fig. 26, 1894. Miller, N. A. Geol. Pal., 2nd. App., p. 787, fig. 1458, 1897.

3799. *Cuneamya coriformis* Miller Cotype
Maysville—(McMillan) (Ord.). Cincinnati, Ohio.
Miller, N. A. Geol. Pal., p. 474, figs. 805–806, 1899.

4012. *Cyathocrinus blairi* Miller and Gurley 3 Cotypes
4025. Chouteau limestone (Miss.). Sedalia, Missouri.
4026. Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 67, pl. 4, figs. 11–15, 1895.

4027. *Cyathocrinus blairi* Miller and Gurley Plesiotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 50, pl. 3, figs. 21–22, 1896.

1949. *Cyathocrinus boonvillensis* Miller 56 Paratypes
867. Keokuk group (Miss.). Boonville, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 29, pl. 4, figs. 3–4, 1891.

3838. *Cyathocrinus brittsi* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 70, pl. 4, figs. 35–36, 1895.

4006. *Cyathocrinus chouteauensis* Miller and Gurley Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 68, pl. 4, fig. 16, 1895.

4030. *Cyathocrinus chouteauensis* Miller and Gurley Plesiotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 9, p. 38, pl. 2, fig. 24, 1895.

3841. *Cyathocrinus macadamsi* Miller and Gurley 3 Cotypes
3842. St. Louis Group (Miss.). Alton, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 69, pl. 4, figs. 31–32, 1895.

1473. *Cyathophyllum lincolnensis* Belanski Paratype
Shellrock—Nora Substage (Dev.). Cyathophyllum zonule. Whellwood, Iowa.

1397. *Cyclospongia discus* Miller 2 Cotypes
1398. Helderberg (Dev.). Bunker Hill, Indiana.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 5, pl. 1, figs. 8–9, 1891.

1477. *Cylindrophyllum floydense* Belanski Paratype
Shellrock—Mason City Substage (Dev.). Camarophoria zonule. Nora Springs, Iowa.
Balanski, Am. Mid. Nat., Vol. 11, p. 176, pl. 12, fig. 1, 1928.

3795. *Cymatonota cylindrica* (Miller and Faber) 5 Cotypes
3796. (See *Orthodesma cylindricum* Miller and Faber)
Richmond (Waynesville) (Ord.). Warren County, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 22, pl. 1, figs. 1–4, 1894.

3960. *Cypricardella eximia* Miller and Gurley 4 Cotypes
3961. (= *Microdon? eximia* Miller and Gurley)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 15, pl. 2, fig. 25, 1896.

3263. *Cypricardella borbyi* Miller Holotype
(= *Microdon? gorbyi* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 702, pl. 20, figs. 6–7, 1891. Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 92, pl. 20, figs. 6–7, 1891.

106. *Cyrtoceras amoenum* Miller Holotype
Richmond—(Whitewater) (Ord.). Richmond, Indiana.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 1, p. 105, pl. 3, fig. 8, 1878.

102. *Cyrtoceras faberi* James Holotype
Richmond—(Whitewater) (Ord.). Richmond, Indiana.
James, Jour. Cincinnati Soc. Nat. Hist., Vol. 8, p. 246, pl. 4, figs. 3a–3b, 1886.

300. *Cyrtoceras magister* Miller Holotype
Eden—(Southgate) (Ord.). Columbia Ave., Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 284, Text, fig. 17, 1875. Miller, N. A. Geol. Pal., p. 434, fig. 729, 1889.

103. *Cyrtoceras tenuiseptum* Faber 2 Cotypes
104. Richmond—(Waynesville) (Ord.). Near Waynesville, Ohio.
Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 9, p. 18, pl. 1, figs. 3a–3c, 1886.

105. *Cyrtoceras ventricosum* Miller Holotype
Eden—(Southgate) (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 131, fig. 16, 1875.

2187. *Decadocrinus douglassi* (Miller and Gurley) Holotype
(See *Poteriocrinus douglassi* Miller and Gurley)
Bridger Mts. (Miss.). Bozeman, Montana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 83, pl. 5, figs. 16–17, 1896.

1497 *Devonocidaris primaevus* Belanski 24 Cotypes
Eatonia Faunule—Mason City Substage, Shellrock (Dev.). 4 mi. S. E. of Nora Springs, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, p. 184, pl. 13, figs. 29–34, 1928.

2185. *Dichocrinus douglassi* (Miller and Gurley) Holotype
(See *Platycrinus douglassi* Miller and Gurley)
Bridger Mts. (Miss.). Bozeman, Montana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 86, pl. 5, figs. 18–19, 1896.

3987–3989. *Dielasma occidentalis* (Miller) 27 Cotypes
(See *Terebratula occidentalis* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 59, pl. 9, figs. 10–13, 1893.

3920. *Discina sampsoni* Miller 3 Cotypes
(=*Orbiculoidea sampsoni* (Miller))
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 80, pl. 13, figs. 10–12, 1891.

868. *Dizygocrinus euconus* var. *abscissus* Rowley and Hare 17 Cotypes
(See *Batocrinus venustus* Miller)
Keoukuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 67, pl. 11, figs. 11–12, 1891.

3239. *Dizygocrinus unionensis* Worthen 64 Cotypes
(See *Batocrinus pulchellus* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 68, pl. 11, figs. 13–14, 1891.

3219. 3219a. *Dizygocrinus unionensis* var. *divalis* Miller 13 Cotypes
(See *Batocrinus divalis* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 22, pl. 3, figs. 6–7, 1892.

3267. 3267a. *Dorycrinus suboviformis* Miller and Gurley Holotype and 15 Paratypes
Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 30, pl. 2, figs. 7–9, 1897.

1967. *Dystactospongia minor* Ulrich and Everett Plesiotype
Plattin, No. 32 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, p. 127, 1928. Ulrich and Everett, Geol. Surv. Ill., Vol. 8, p. 278, pl. 8, figs, 3a–3b, 1890.

1441. *Eatonia gregaria* Belanski Paratype
Shellrock—Mason City Substage (Dev.). Eatonia zonule. 4 mi. S. E. of Nora Springs, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, p. 196, pl. 15, figs. 7–17, 1928.

3902– *Edmondia albersi* Miller and Gurley 6 Cotypes
3904. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 8, pl. 1, figs. 9–11, 1896.

3921. *Elymella missouriensis* Miller and Gurley 2 Cotypes
3922. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 15, pl. 2, figs. 11–12, 1896.

3808. *Endoceras bristolense* Miller 2 Cotypes
3809. Richmond—(Maquoketa) (Ord.). Bristol, Illinois.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 5, p. 85, pl. 4, figs. 2–2a, 1882.

3268. *Endoceras kentuckiensis* Miller ms. Holotype?
(Marked type in Miller Coll.)

1320. *Eocidaris blairi* Miller 8 Cotypes
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 73, pl. 12, figs. 1–2, 1891.

3215. *Eretmocrinus leucosia* Hall Paratype
(See *Batocrinus blairi* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 39, pl. 6, figs. 7–10, 1892.

3276. *Eucalyptocrinus crassus* Hall Figured specimen
Niagara group (Sil.). Shelby County, Indiana.
Wetherby, Jour. Cincinnati Soc. Nat. Hist., Vol. 2, pl. 8, figs. 5–8, p. 7, footnoote, 1879.

3269. *Eucalyptocrinus* (*Hypanthocrinus*) *proboscidalis* Miller Plasto-holotype
Niagara group (Sil.). Pontiac, Ohio.
Miller, Jour. Cincinnati Soc. Nat. Hist., p. 224, pl. 9, fig. 2, Vol. 5, 1882.

1960. *Eunella lincklaeni* Hall Plasto-cotype
Hamilton (Dev.). Delphi Falls, New York.
American Museum of National History 5219.

3996. *Glossina sedaliensis* Miller 5 Cotypes
3997. (See *Lingula sedaliensis* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 54, pl. 9, fig. 2, 1892.

3955. *Goniatites blairi* Miller and Gurley Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 35, pl. 4, figs. 4–5, 1896.

3896. *Goniatites jessieae* Miller and Gurley 4 Cotypes
3897. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 46, pl. 5, figs. 18–20, 1896.

1467. *Gypidula comis* (Owen) Plesiotype
Cedar Valley—Upper Davenport Substage (Dev.). Solon, Iowa.

Fenton and Fenton, Univ. Ia. Stud. Nat. Hist., Vol. 12, No. 7, p. 9, 1928.

3146. *Gypidula cornuta* Fenton and Fenton Plesiotype
Hackberry—Cerro Gordo Substage (Dev.), Xenocidaris zonule. R. B. and T. Co. Pit, Rockford, Iowa.
Fenton and Fenton, The Stratigraphy and Fauna of the Hackberry Stage of the Upper Devonian, Vol. 1, p. 121, figs. 26–31, 1924.

1468. *Gypidula cornuta parva* Fenton and Fenton Plesiotype
Hackberry—Cerro Gordo Substage (Dev.)., Devonocidaris zonule. Bird Hill, Near Rockford, Iowa.
Fenton and Fenton, The Stratigraphy and Fauna of the Hackberry Stage of the Upper Devonian, Vol. 1, p. 123, pl. 25, figs. 32–35, 1924.

4521. *Hallopora dalei* (Milne—Edwards and Haime) Plesiotype Thin section
Maysville (Mt. Hope) (Ord.). Cincinnati, Ohio.
G. B. Twitchell Coll.

4511. *Hallopora ramosa* (D'Orbigny) Plesiotype Thin section
Maysville (McMillan) (Ord.). Cincinnati, Ohio.
G. B. Twitchell Coll.

3871. *Heterocrinus heterodactylus* Hall Plesiotype
Eden. Cincinnati, Ohio.
Hall, Pal. New York, Vol. 1, p. 279, pl. 76, figs. 1a-o, 1847.
Meek, Geol. Surv. Ohio. Pal, Vol. 1, p. 12, pl. 1, figs. 1a–1b, 1873.

4510. *Heterotrypa* (On *Monticulipora* on *Platystrophia*) Nicholson Plesiotype, Thin section
Maysville (Bellevue) (Ord.). Clover Creek, Cincinnati, Ohio.
G. B. Twitchell Coll.

4515. *Heterotrypa* (On *Monticulipora* on *Platystrophia*) Nicholson Plesiotype, Thin section
G. B. Twitchell Coll.

4517. *Heterotrypa frondosa* (D'Orbigny) Plesiotype, Thin Section
Maysville (Mt. Auburn) (Ord.). Cincinnati, Ohio.
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 30, fig. 12, 1934.

4524. *Homotrypella hospitalis* (Nicholson) Plesiotype, Thin Section
Maysville (Mt. Auburn) (Ord.).
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 30, fig. 17, 1934.

4501. *Homotrypella hospitalis* (Nicholson) Plesiotype, Thin section
Mt. Auburn var. Richmond (Waynesville) (Ord.).
G. B. Twitchell Coll.

4522. *Homotrypella hospitalis* (Nicholson) Plesiotype, Thin section
Richmond (Waynesville) (Ord.). Cincinnati, Ohio.
G. B. Twitchell Coll.

3990. *Hustedia triangularis* (Miller) 2 Cotypes
3991. (See *Retzia triangularis* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 61, pl. 9, figs. 25–26, 1892.

3384. *Hydreionocrinus depressus* Hall Holotype and 5 Paratypes
3385. Kaskaskia group (Miss.). Kings Mt.
Wetherby, Jour. Cincinnati Soc. Nat. Hist., Vol. 3, p. 325, pl. 9, figs. 1–4, 6, 1880.

3887. *Hyolithes? dubius* Miller and Faber Cotype
Richmond (Ord.). Versailles, Indiana.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 155, pl. 8, fig. 23?, 1894.

3899. *Hyolithes lanceolatus* Miller 3 Cotypes
3900. Chouteau limestone (Ord.). Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 317, pl. 9, figs. 35–36, 1894.

1334. *Hyolithes versaillesensis* Miller and Faber Cotype
Richmond (Ord.). Versailles, Indiana.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 155, pl. 8, figs. 20–22, 1894.

1492. *Hypothyridina magister* Belanski Paratype
Shellrock (Dev.).—Mason City Substage, Camarophoria zonule. Nora Springs, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, p. 198, pl. 15, figs. 1–6, 1928.

3892. *Igoceras quincyense* (McChesney) Holotype
(See *Platyceras missouriense* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 82, pl. 14, fig. 2, 1891.

3890. *Igoceras quincyense* (McChesney) 2 Paratypes
3891. (See *Platyceras pettisense* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 81, pl. 14, fig. 1891.

3953. *Leiopteria speciosa* Miller and Gurley 2 Cotypes
3954. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 13, pl. 2, fig. 10, 1896.

3956–
3959. *Leiopteria subovata* Miller and Gurley 5 Cotypes
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 13, pl. 2, figs. 7–9, 1896.

1498. *Lepidocentrus? thomasi* Belanski 12 Cotypes
Shellrock—Mason City Substage (Dev.)., Camarophoria faunule. Nora Springs, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, p. 181, pl. 13, figs. 1–16, 1928.

3273. *Leptopora gorbyi* Miller 16 Cotypes
(See *Leptopora typa* Winchell)
Chouteau limestone (Miss.). Cooper County, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 6, pl. 1, figs. 1–4, 1891.

3273. *Leptopora typa* Winchell 16 Cotypes
(See *Leptopora gorbyi* Miller)

Chouteau limestone (Miss.). Cooper County, Missouri.
Winchell, Proc. Acad. Nat. Sci. Phil., p. 3, 1863. Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 6, pl. 1, figs. 1–4, 1891.

3785. *Leptotrypa calceola* (Miller and Dyer) 104 Cotypes
(See *Monticulipora calceola* Miller and Dyer)
Maysville—Corryville (Ord.). Cincinnati, Ohio.
Miller and Dyer, Jour. Cincinnati Soc. Nat. Hist., Vol. 1, p. 26, pl. 1, figs. 11–11a, 1878.

3895. *Lichas byrnesanus* Miller and Gurley Holotype
(=*Corydocephalus byrnesanus* (Miller and Gurley))
Niagaran—Laurel (Sil.). Near Madison, Indiana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 3, p. 78, pl. 8, figs. 8–9, 1893.

599. *Lichenocrinus affinis ashmanni* Faber Figured specimen
Decorah (Ord.). Fountain, Minnesota.
Fenton, Amer. Mid. Nat., Vol. 11, No. 9, p. 498, pl. 37, fig. 12, 1929.

10008–10010. *Lichenocrinus columns* (Unattached) Faber 3 Figured specimens
McMicken (Ord.). Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 457, pl. 27, figs. 1–3, 1929.

10017. *Lichenocrinus crateriformis* Hall 2 Plesiotypes
10022. Waynesville (Ord.). N. of L.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 470, pl. 32, figs. 5–7, 1929.

875. *Lichenocrinus* aff. *crateriformis* Hall Figured specimen
Beloit formation. Black River, Bed 4 (Ord.), Minneapolis, Minnesota.
Fenton, Amer. Mid. Nat., Vol. 11, No. 9, p. 496, pl. 37, figs. 5–8, 1929.

10011. *Lichenocrinus* cf. *dubius* Miller Figured specimen
Fairmount (Ord.). Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 457, pl. 27, fig. 4, 1929.

3875. *Lichenocrinus dubius* Miller Plesiotype
Cincinnatian (Ord.). Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 464, pl. 29, fig. 9, pl. 30, figs. 1–3, 1929.

10016. *Lichenocrinus dubius* Miller Plesiotype
Mt. Hope (Ord.). Mt. Hope Road Quarry, Cincinnati, Ohio.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 3, p. 234, pl. 7, figs. 5–5a, 1880.

10037. *Lichenocrinus dubius* Miller Plesiotype
McMicken (Fulton reoccurrence) (Ord.)., Rapid Run, Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 464, pl. 29, fig. 9; pl. 30, figs. 1–3, 1929.

1390. *Lichenocrinus dyeri* Hall Plesiotype
Maysville—Corryville (Ord.). Cincinnati, Ohio.
Meek, Geol. Surv. Ohio Pal., Vol. 1, pt. 2, p. 51, pl. 3, figs. 2 and 3a–3h, 1873. Faber, Am., Nat., Vol. 11, p. 469, pl. 27, fig. 5; pl. 34, figs. 7–12, 1929.

10012. *Lichenocrinus dyeri* Hall 3 Plesiotypes
10023. Corryville (Ord.). Fairview Heights, Cincinnati, Ohio.
10024. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 469, pl. 27, fig. 5; pl. 34, figs. 7–12, 1929.

10046. *Lichenocrinus irregularis* Faber Holotype
Whitewater (Ord.). Dodge Creek, Oxford, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 473, pl. 32, fig. 13, 1929.

10040. *Lichenocrinus kemperi* Faber Holotype
Elkhorn (Ord.). 2½ mi. S. of Eaton, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 473, pl. 32, figs. 1–4, 1929.

1388. *Lichenocrinus milleri* Faber Paratype
(See *Lichenocrinus tuberculatus* Miller)
Richmond (Ord.). Hill's Mills, Near Richmond, Indiana.
Miller, Jour. Cincinnati Quart. Jour., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 476, pl. 33, figs. 3–9, 1929.

10030. *Lichenocrinus milleri* Faber 2 Paratypes
10047. Elkhorn (Ord.). Osgood, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 476, pl. 33, figs. 3–9, 1929.

3878. *Lichenocrinus milleri* Faber Paratype
(See *Lichenocrinus tuberculatus* Miller)
Richmond (Ord.). Hill's Mills, Near Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 476, pl. 33, figs. 3–9, 1929.

10029. *Lichenocrinus milleri* Faber Holotype
Whitewater (Ord.). Near Osgood Pike, or place of type.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 476, pl. 33, figs. 3–9, 1929.

10029a. *Lichenocrinus milleri* Faber Paratype
Whitewater (Ord.). Near Osgood Pike or place of type.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 476, pl. 33, figs. 3–9, 1929.

10021. *Lichenocrinus milleri* Faber Paratype
(See *Lichenocrinus tuberculatus* Miller)
Elkhorn (Ord.). Lytle, Near Lebanon, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 476, pl. 33, figs. 3–9, 1929.

881. *Lichenocrinus* aff. *nodosus minnesotensis* Faber Figured Specimen
Beloit Formation—Black River, (bed 4) (Ord.)., Minneapolis, Minnesota.

Fenton, Am. Mid. Nat., Vol. 11, No. 9, p. 495, pl. 37, figs. 2–3, 1929.

10032. *Lichenocrinus nodosus* Faber Holotype and Paratype
10033. Waynesville (Ord.). Weisburg, Indiana, Cut. 14.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 477, pl. 33, figs. 10–11, 1929.

10006. *Lichenocrinus schlemmeri* Faber Paratype
Southgate (Ord.). Rapid Run Creek, Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 466, pl. 31, figs. 1–3, 1929.

10026. *Lichenocrinus shideleri* Faber Holotype and Paratype
10028. Saluda (Ord.). Mixerville, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 478, pl. 34, figs. 3–4; pl. 28, fig. 9, 1929.

10025. *Lichenocrinus shideleri regularis* Faber Paratype
Elkhorn (Ord.). Osgood, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 479, pl. 34, figs. 1–2; pl. 28, fig. 8, 1929.

1387. *Lichenocrinus shideleri regularis* Faber Paratype
(See *Lichenocrinus tuberculatus* Miller)
Richmond (Ord.). Hill's Mills, Near Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 479, 1929.

10027. *Lichenocrinus shideleri regularis* Faber Holotype
Elkhorn (Ord.). Richmond, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 479, pl. 28, fig. 8; pl. 34, figs. 1–2, 1929.

10007. *Lichenocrinus stetteri* Faber Holotype
Southgate (Ord.). Rapid Run Creek, Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 466, pl. 30, figs. 4–5, 1929.

1387. *Lichenocrinus tuberculatus* Miller Cotype
(=*Lichenocrinus shideleri regularis* Faber)
Richmond (Ord.). Hill's Mills, Near Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 474, pl. 33, figs. 1–2, 1929.

3978. *Lichenocrinus tuberculatus* Miller 7 Cotypes
3983. Richmond (Ord.). Hill's Mills, Near Richmond, Indiana.
3877. Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 474, pl. 33, figs. 1–2, 1929.

10019. *Lichenocrinus tuberculatus* Miller Plesiotype
Elkhorn (Ord.). 2½ mi. S. of Eaton, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 457, pl. 28, fig. 6, 1929.

10021. *Lichenocrinus tuberculatus* Miller Cotype
(=*Lichenocrinus milleri* Faber)
Elkhorn (Ord.). N. of L. and Lytle, near Lebanon, Ohio.

Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 474, pl. 33, figs. 1–2, 1929. Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874.

10014. *Lichenocrinus tuberculatus* Miller — Plesiotype
Elkhorn (Ord.). Whitewater River, Richmond, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 474, pl. 28, fig. 1, 1929.

10036. *Lichenocrinus tuberculatus* Miller — Plesiotype
Elkhorn (Ord.). Whitewater River, Richmond, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 474, pl. 29, fig. 4, 1929.

10035. *Lichenocrinus tuberculatus* Miller — Plesiotype
Elkhorn (Ord.). Whitewater River, Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 459 and 474, pl. 29, fig. 3, 1929.

10039. *Lichenocrinus tuberculatus* Miller — 2 Plesiotypes
10039a. Elkhorn (Ord.). N. of L.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 460 and 474, pl. 29, figs. 7–8, 1929.

10020. *Lichenocrinus tuberculatus* Miller — Plesiotype
Elkhorn (Ord.). Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 459, and 474, pl. 28, figs. 10–11, 1929.

10015. *Lichenocrinus tuberculatus* Miller — Plesiotype
Elkhorn (Ord.). N. of L.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 246, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 457 and 474, pl. 28, fig. 3, 1929.

10031. *Lichenocrinus tuberculatus* Miller — Plesiotype
Elkhorn (Ord.). Whitewater River, Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 474, pl. 33, fig. 1, 1929.

10034. *Lichenocrinus tuberculatus* Miller — Plesiotype
Elkhorn (Ord.). N. of L.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, pp. 460 and 474, pl. 29, fig. 6, 1929.

3878. *Lichenocrinus tuberculatus* Miller — 6 Cotypes
1388. (=*Lichenocrinus milleri* Faber)
Richmond (Ord.). Hill's Mills, Near Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 346, fig. 38, 1874. Faber, Am. Mid. Nat., Vol. 11, p. 474, pl. 33, figs. 1–2, 1929.

10029a. *Lichenocrinus tuberculatus* Miller — Figured specimen
(See *Lichenocrinus milleri* Faber.)
Whitewater. Near Osgood Pike, or place of type.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 476, pl. 33, figs. 3–9, 1929.

10001. *Lichenocrinus twitchelli* Faber Holotype and 2 Paratypes
10002.
10003.
10013. Southgate (Ord.). Rapid Run Creek, Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 463, pl. 31, figs. 6–10, 1929.

10004. *Lichenocrinus vaupeli* Faber Holotype
Southgate (Ord.). Rapid Run, Cincinnati, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 467, pl. 31, figs. 4–5, 1929.

10038. *Lichenocrinus* Faber Figured specimen
Waynesville (Ord.). Cut 14, Weisburg, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 457, pl. 29, fig. 5, 1929.

10018. *Lichenocrinus* Faber Figured specimen
Waynesville (Ord.). Cut 14, Weisburg, Indiana.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 457, pl. 28, fig. 5, 1929.

10043. *Lichenocrinus* (young) Figured specimen
Liberty (Ord.). 4 mi. Creek, Oxford, Ohio.
Faber, Am. Mid. Nat., Vol. 11, No. 9, p. 460, pl. 28, fig. 13, 1929.

600. *Lichenocrinus* Figured specimen
Decorah (Ord.). N. W.¼, S. E. ¼, Sec. 35, T10TN, Rx111W, Near Rochester, Minnesota.
Fenton, Am. Mid. Nat., Vol. 11, No. 9, p. 497, pl. 37, fig. 10, 1929.

3993– *Lingula gorbyi* Miller 9 Cotypes
3995. Chouteau limestone (Ord.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 55, pl. 9, figs. 3–4, 1892.

3938. *Lingula parrishi* Miller 2 Cotypes
3939. (Pennsylvanian) Layer 85. Kansas City, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 53, pl. 8, fig. 2; pl. 9, fig. 1, 1892.

3996. *Lingula sedaliensis* Miller 5 Cotypes
3997. (=*Glossina sedaliensis* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 54, pl. 9, fig. 2, 1892.

3936. *Lunulicardium grande* Miller and Gurley 2 Cotypes
3937. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 5, pl. 1, figs. 1–3, 1896.

3889. *Lunulicardium retrorsum* Miller and Gurley Cotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 6, pl. 2, fig. 26, 1896.

1971. *Maclurea bigsbyi* var. *dixonensis* Ulrich Plasto-plesiotype
(=*Maclurites bigsbyi dixonensis* (Ulrich))

Plattin, No. 27 (Ord.). S. Beckett Hill, Ste. Genevive County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, No. 3, p. 137, pl. 7, figs. 1–3, 1928.
Walker Museum 33422.

1970. *Maclurea bigsbyi* var. *dixonensis* Ulrich Plasto-plesiotype
(=*Maclurites bigsbyi dixonensis* (Ulrich))
Plattin, No. 26, (Ord.). S. Beckett Hill, Ste. Genevieve, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, No. 3, p. 137, pl. 7, fig. 6, 1928.
Walker Museum 25936.

832a. *Maclurea bigsbyi* var. *dixonensis* Ulrich Plasto-holotype
832b. (=*Maclurites bigsbyi dixonensis* (Ulrich))
Mohawkian (Ord.). Dixon, Illinois.
Ulrich, Geol. Minn., Vol. 3, pt. 2, p. 1039, 1897.

1956. *Maclurina manitobensis* (Whiteaves) Plasto-holotype
Trenton—Galena (Ord.). Black Island, Swampy Harbor, and Lake Winnipeg.
Whiteaves, Trans. Roy. Soc. Canada, Vol. 7, Sec. 4, p. 75, pl. 12; pl. 13, figs. 1–2, 1890.

1970. *Maclurites bigsbyi dixonensis* (Ulrich) Plasto-pleisotype
(See *Maclurea bigsbyi* var. *dixonensis* Ulrich)
Plattin, No. 26 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, No. 3, p. 137, pl. 7, fig. 6, 1928.
Walker Museum 25936.

1971. *Maclurites bigsbyi dixonensis* (Ulrich) 2 Plasto-plesiotypes
(See *Maclurea bigsbyi* var. *dixonensis* Ulrich)
Plattin, No. 27 (Ord.). S. Beckett Hill, Ste. Geneveive County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, No. 3, p. 137, pl. 7, figs. 1–3, 1928.
Walker Museum 33422.

832a. *Maclurites bigsbyi dixonensis* (Ulrich) Plasto-holotype
832b. (See *Maclurea bigsbyi* var. *dixonensis* Ulrich)
Mohawkian (Ord.). Dixon, Illinois.
Ulrich, Geol. Minn., Vol. 3, pt. 2, p. 1039, 1897.

3334. *Macrochilina blairi* Miller Holotype and 2 Paratypes
3334a. (=*Soleniscus? blairi* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 84, pl. 14, fig. 5, 1891. Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 694, pl. 14, fig. 5, 1892.

3930– *Macrodon blairi* Miller and Gurley 20 Cotypes
3935. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 11, pl. 2, fig. 19–24, 1896.

3905. *Macrodon facetus* Miller and Gurley 6 Cotypes
3906. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 10, pl. 1, fig. 14–16, 1896.

3907. *Macrodon pettisensis* Miller and Gurley 2 Cotypes
3908. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 10, pl. 2, fig. 17–18, 1896.

3846. *Megistocrinus ornatus* Miller and Gurley 2 Cotypes
3847. Hamilton group (Dev.). Clark County, Indiana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 42, pl. 2, figs. 15–17, 1895.

3869. *Metacoceras cavatiforme* Hyatt 3 Plesiotypes
3870. (Pennsylvanian). Kansas City, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 326, pl. 11, figs. 5–7, 1894.

3998– *Microcyclus blairi* Miller 7 Cotypes
4000. Choteau limestone (Miss.). Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 261, pl. 9, figs. 27–28, 1894.

3960. *Microdon? eximia* (Miller and Gurley) Cotype
(See *Cypricardella eximia* Miller and Gurley)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 15, pl. 2, fig. 25, 1896.

3961. *Microdon? eximia* (Miller and Gurley) 3 Cotypes
(See *Cypricardella eximia* Miller and Gurley)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 15, pl. 2, fig. 25, 1896.

3263. *Microdon? gorbyi* Miller Holotype
(See *Cypricardella gorbyi* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheet, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 92, pl. 20, figs. 6–7, 1891.

3786. *Modiolopsis corrugata* Miller and Faber 4 Cotypes
(= *Whiteavesia corrugata* (Miller and Faber))
Maysville—Corryville (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 15, p. 79, pl. 1, fig. 1, 1892.

3881. *Modiolopsis modiolaris* (Conrad) 2 Plesiotypes
3882. (Cincinnatian) Cincinnati, Ohio?
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 149, fig. 17, 1874.

3790. *Modiolopsis pholadiformis* Hall Plesiotype
(= *Whiteavesia pholadiformis* (Hall))
Richmond (Ord.). Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 282, 1874.

419. *Monotrypa magna* Ulrich 2 Plesiotypes
420. Plattin, No. 32 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Ulrich, Am. Mid. Nat., Vol. 11, No. 2, p. 129, 1928.

3785. *Monticulipora calceola* Miller and Dyer 104 Cotypes
(= *Leptotrypa calceola* (Miller and Dyer))
Maysville—Corryville (Ord.). Cincinnati, Ohio.

Miller and Dyer, Jour. Cincinnati Soc. Nat. Hist. Vol. 1, p. 26, pl. 1, figs. 11–11a, 1878.

4502. *Monticulipora molesta* Nicholson — Thin Section
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 29, fig. 10, 1934.

4520. *Monticulipora epidermata* Ulrich and Bassler — Thin Section
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 29, fig. 11, 1934.

3802. *Mourlonia worthenana* (Miller) — Holotype
(See *Murchisonia worthenana* Miller)
Niagaran—Racine (Sil.). Bridgeport, Illinois.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 5, p. 225, pl. 9, fig. 3, 1882.

3802. *Murchisonia worthenana* Miller — Holotype
(=*Mourlonia worthenana* (Miller))
Niagaran—Racine (Sil.). Bridgeport, Illinois.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 5, p. 225, pl. 9, fig. 3, 1882.

753. *Myelodactylus bridgeportensis* Miller — 4 Cotypes
785. Niagaran—Racine Dolomite (Sil.). Chicago, Illinois.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol 3, p. 141, pl. 4, figs. 2a-c, 1880.

3924– *Mytilarca jessieae* Miller and Gurley — 23 Cotypes
3928. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 14, pl. 2, figs. 1–6, 1896.

3782. *Newlandia sarcinula* Fenton and Fenton — Holotype
(Altyn). S. Shoulder Spot Mt. Glacier National Park, Montana.
Fenton and Fenton, Jour. Geol., Vol. 39, No. 7, p. 685, pl. 7, figs. 1–2, 1931.

3029. *Notalacerta missouriensis* Butts — Topotype
(=*Collettosaurus missouriensis* (Butts))
(Upper Coal Measures) Kansas City, Missouri.
Butts, Kansas City Sci., Vol. 5, No. 2, p. 18, 1891. Charles W. Gilmore, Smithsonian Misc. Coll., Vol. 80, No. 3, p. 58, fig. 30, 1927.

1317. *Nucleocrinus venustus* Miller and Gurley — 2 Cotypes
Onondagan—Columbus limestone (Dev.). Columbus, Ohio.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 3, p. 63, pl. 6, figs. 28–30, 1893.

3213. *Orospira bigranosa* Ulrich — Plasto-holotype
Cotter, Missouri.

3920. *Orbiculoidea sampsoni* (Miller) — 3 Cotypes
(See *Discina sampsoni* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 80, pl. 13, figs. 10–12, 1891.

3326. *Orthis* (*Platystrophia*) *crassa* James — 2 Cotypes?
(=*Platystrophia crassa* (James))
Maysville (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 20, 1874.

3307. *Orthis scovillei* Hall and Clarke 7 Cotypes
(= *Plectorthis* (*Austinella*) *scovillei* (Miller))
Hudson River group (Ord.). Lebanon, Ohio.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 5, p. 40, pl. 1, fig. 5, 1882.

360. *Orthoceras albersi* Faber and Miller 5 Cotypes
361. Trenton—Upper (Ord.). W. Covington, Kentucky.
1323. Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17,
1323a. p. 140, pl. 8, fig. 51–54, 1894.

1331. *Orthoceras byrnesi* Miller 67 Cotypes
3304. Maysville—Fairmount (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 126, fig. 13, 1875. Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 4, p. 319, pl. 8, fig. 8, 1881.

3305. *Orthoceras cincinnatiense* Miller Cotype
Hudson River Group (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart., Jour. Sci., Vol. 2, p. 127, 1875. Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 4, p. 319, pl. 8, fig. 5, 5a, 1881.

353. *Orthoceras colleti* Miller Holotype
Pennsylvanian — (Upper Coal Measures). Kansas City, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 67, pl. 10, fig. 1, 1892. Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 321, pl. 10, fig. 1, 1894.

356. *Orthoceras duseri* Hall and Whitfield 3 Cotypes
(Cotypes of *Orthoceras fosteri* Miller)
Richmond—Waynesville (Ord.). Clinton County, Ohio.
Miller, Cincinnati Quart.Jour. Sci., Vol. 2, p. 127, 1875. Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 4, p. 319, pl. 8, figs. 7–7a, 1881.

351. *Orthoceras dyeri* Miller Plesiotype
Maysville—Corryville (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 125, fig. 11, 1875.

352. *Orthoceras dyeri* Miller 2 Cotypes
Maysville—Corryville (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 125, fig. 11, 1875. Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 3, p. 236, pl. 7, fig. 7, 1880.

356. *Orthoceras fosteri* Miller 3 Cotypes
(= *Orthoceras duseri* Hall and Whitfield)
Richmond—Waynesville (Ord.). Clinton County, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 127, 1875. Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 4, p. 319, pl. 8, fig. 7–7a, 1881.

1329. *Orthoceras harperi* Miller 22 Cotypes
1330. Maysville—Corryville (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 128, 1875. Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 4, p. 319, pl. 8, figs. 6–6a, 1881.

357. *Orthoceras ludlowense* Miller and Faber 2 Cotypes
Trenton—upper (Ord.). Ludlow, Kentucky.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 139, pl. 7, figs. 1–2, 1884.

354. *Orthoceras mohri* Miller 84 Cotypes
355. Richmond (Ord.). Versailles, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 124, fig. 10, 1875.

1328. *Orthoceras transversum* Miller 34 Cotypes
Eden (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 2, p. 129, 1875. Miller, N. A. Geol. Pal., p. 452, fig. 755, 1889.

3795. *Orthodesma cylindricum* Miller and Faber 5 Cotypes
3796. (See *Cymatonota cylindrica* (Miller and Faber)
Waynesville (Ord.). Warren County, Ohio.
Miller, and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 22, pl. 1, figs. 1–4, 1894.

3788. *Orthodesma cymbula* Miller and Faber 2 Cotypes?
(See *Rhytimya mickleboroughi* (Whitfield))
Maysville—Fairmount (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 143, pl. 8, figs. 7–9, 1894.

3314. *Orthonychia boonvillensis* Miller Holotype and Paratype
3314a. (See *Platyceras boonvillense* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 82, pl. 14, figs. 15–16, 1891.

1470. *Pachyphyllum websteri* Belanski 2 Paratypes
1478. Shellrock—Mason City Substage (Dev.). Pachyphyllum zonule.
Shale Band near C. M. and St. Paul Depot, Nora Springs, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, No. 5, p. 171, pl. 12, fig. 3, 1928.

3728a. *Paedumias transitans* Walcott 7 Homeotypes
Kintzers Formation (late Eocambrian). Near Fruitville County, Pensylvania.

1953. *Paleophycus tubulare* Hall Plasto-Plesiotype
Plattin, No. 15 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, No. 2, p. 126, pl. 1, fig. 5, 1928.

3952. *Palaeosolen occidentalis* Miller and Gurley 2 Cotypes
3901. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 16, pl. 2, figs. 13–14, 1896.

3893. *Pasceolus claudei* Miller 10 Cotypes
Maysville—Bellevue (Ord.). Near Maysville, Kentucky.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 6, fig. 3, 1874.

3310. *Pasceolus darwini* Miller 5 Cotypes?
Miller, Cincinnati Quar. Jour. Sci., Vol. 1, p. 5, figs. 1–2, 1874.

3311. *Pentremites occidentalis* Miller Holotype?
Kaskaskia group (Miss.). Black Hills region, Dakota.
Marked type in Miller Coll.

799. *Periechocrinus pyriformis* Wachsmuth and Springer Cotype
(= *Periechocrinus urniformis* (Miller)
(See *Saccocrinus pyriformis* Miller)
Niagaran—Racine Dolamite (Silurian). Chicago, Illinois.
Miller, Jour. Cin. Soc. Nat. Hist., Vol. 5, p. 81, pl. 3, figs. 3, 3a, 1882.

799. *Periechocrinus urniformis* (Miller) Cotype
(See *Periechocrinus pyriformis* Wachsmuth and Springer).
(See *Saccocrinus pyriformis* Miller)
Niagaran—Racine Dolamite (Sil.). Chicago, Illinois.
Miller, Jour. Cin. Soc. Nat. Hist., Vol. 5, p. 81, pl. 3, figs. 3, 3a, 1882.

4516. *Peronopora vera* Ulrich Thin Section
Fairmount.
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 30, fig. 15, 1934.

4507. *Peronopora vera* Ulrich Thin Section
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 29, fig. 6, 1934.

4509. *Peronopora vera* Ulrich Thin Section
Between lamella.
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 30, fig. 13, 1934.

4515. *Peronopora vera* Ulrich Thin Section
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 29, figs. 8–9, 1934.

3364. *Phialocrinus harii* (Miller and Gurley) Plesiotype
(See *Aesiocrinus harii* Miller and Gurley)
(Pennsylvanian) Kansas City, Missouri.
Miller and Gurley, Jour. Cin. Soc. Nat. Hist., Vol. 13, p. 16, pl. 3, fig. 1, 1890.

4851. *Pholidops greenei* Miller and Gurley 17 Cotypes
(Devonian) Charleston, Indiana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 48, pl. 3, fig. 16–21, 1897.

3312. *Phragmoceras missouriense* Miller Holotype and 5 Paratypes
3312a. Chouteau limestone (Miss.). Pettis County, Missouri.
Miller, 17th Rep. Geol. Surv. Ind., p. 699, pl. 15, fig. 2, 1891.

3966. *Physetomya acuminata* Ulrich Geno-holotype
Maysville—Fairmount (Ord.). Cincinnati, Ohio.
Ulrich, Geol. Surv. Ohio, Vol. 7, p. 693, pl. 49, fig. 12–14, 1893.

3313. *Pisocrinus campana* Miller Holotype and 5 Paratypes
3313a. Niagara group (Sil.). Wabash, Indiana.
Miller, 17th Ann. Rep. Ind. Dep. Geol. Nat. Res., p. 642, pl. 11, fig. 4–5, 1892.

3883– *Pisocrinus gemmiformis* Miller 7 Cotypes
3385. Niagaran group (Sil.). Osgood, Indiana.
Miller, Jour. Cin. Soc. Nat. Hist., Vol. 2, p. 113, pl. 9, figs. 6–6c, 1879.

3314. *Platyceras boonvillense* Miller — Holotype and Paratype
3314a. (=*Orthonychia boonvillensis* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 82, pl. 14, fig. 15–16, 1891.

3892. *Platyceras missouriense* Miller — Holotype
(=*Igoceras quincyense* (McChesney))
Burlington group (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 82, pl. 14, fig. 2, 1891.

3890. *Platyceras pettisense* Miller — 2 Cotypes
3891. (=*Igoceras quincyense* (McChesney))
Burlington group (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 81, pl. 14, fig. 1, 1891.

3316. *Platycrinus acclivus* Miller — Holotype and 2 Paratypes
3316a. Burlington group (Miss.). Sedalia, Missouri.
Miller, Bull. Geol. Surv. Mo., No. 4, p. 12, pl. 1, figs. 9–10, 1891.

3867. *Platycrinus aequalis* Hall — Holotype
(=*Platycrinus batiola* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 22, pl. 3, figs. 1–2, 1891.

3858. *Platycrinus amabilis* Miller — 3 Cotypes
3859. ? Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 19, pl. 2, fig. 9–10, 1891.

3817. *Platycrinus americanus* Owen and Shumard — Marked Holotype
(=*Platycrinus broadheadi* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 21, pl. 2, fig. 15, 1891.

3867. *Platycrinus batiola* Miller — Holotype
(See *Platycrinus aequalis* Hall)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Mo. Geol. Surv., Bull. No. 4, p. 22, pl. 3, fig. 1–2, 1891.

2184. *Platycrinus bozemanensis* Miller and Gurley, — Holotype and Paratype
2184a. Burlington group (Miss.). Bozeman, Montana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 42, pl. 3, fig. 5, 1897.

3817. *Platycrinus broadheadi* Miller — Marked Holotype
(See *Platycrinus americanus* Owen and Shumard)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 21, pl. 2, fig. 15, 1891.

3317. *Platycrinus carchesium* Miller — Holotype
(See *Platycrinus pileiformis* Hall)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Missouri, Bull. No. 4, p. 23, pl. 3, figs. 6–7, 1891.

3862. *Platycrinus casula* Miller and Gurley Holotype
Burlington (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 76, pl. 4, figs. 37–40, 1895.

4008. *Platycrinus chouteauensis* Miller 3 Cotypes
4028. Chouteau limestone (Miss.). Sedalia, Missouri.
4029. Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 268, pl. 2, figs. 14–15, 1894.

4018. *Platycrinus clinatus* Miller and Gurley 11 Cotypes
4020– Chouteau limestone, (Miss.). Sedalia, Missouri.
4022. Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 74, pl. 4, figs. 26–30, 1895.

4002. *Platycrinus colletti* Miller 2 Cotypes
4023. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 268, pl. 2, figs. 16–17, 1894.

4011. *Platycrinus cortina* Miller and Gurley 3 Cotypes
4024. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 5, p. 40, pl. 3, figs. 15–16, 1894.

2368. *Platycrinus discoideus* Owen and Shumard
2369. Holotype and 5 Paratypes
(=*Platycrinus pulchellus* (*pulcellus*) Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Bull. Geol. Surv. Mo. No. 4, p. 11, pl. 1, fig. 7, 1891.

2185. *Platycrinus douglassi* Miller and Gurley Holotype
(=*Dichocrinus douglassi* (Miller and Gurley)
Bridger Mts. (Miss.). Bozeman, Montana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 86, pl. 5, fig. 18–19, 1896.

3322. *Platycrinus excavatus* Hall Holotype and 4 Paratypes
3322a. (=*Platycrinus sulcatus* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 16, pl. 2, fig. 2, 1891.

4009. *Platycrinus formosus* Miller and Gurley 9 Cotypes
3805. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 72, pl. 4, figs. 20–21, 1895.

3318. *Platycrinus gorbyi* Miller Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo. Bull. No. 4, p. 15, pl. 1, fig. 14, 1891.

3818. *Platycrinus hodgsoni* Miller and Gurley Holotype
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 63, pl. 5, figs. 8–9, 1896.

3851. *Platycrinus illinoisensis* Miller and Gurley 2 Cotypes
3852. Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 62, pl. 5, figs. 5–7, 1896.

4016. *Platycrinus missouriensis* Miller and Gurley Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 73, pl. 4, figs. 22–23, 1895.

3319. *Platycrinus modestus* Miller and Gurley
3319a. Holotype and 9 Paratypes
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 77, pl. 4, figs. 43–45, 1895.

4017. *Platycrinus pettisensis* Miller and Gurley 4 Cotypes
4019. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 73, pl. 4, figs. 24–25, 1895.

3317. *Platycrinus pileiformis* Hall Holotype
(=*Platycrinus carchesium* Miller)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 23, pl. 3, figs. 6–7, 1891.

2368. *Platycrinus pulchellus* (*pulcellus*) Miller
2369. Holotype and 5 Paratypes
(See *Platycrinus discoideus* Owen and Shumard)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 11, pl. 1, fig. 7, 1891.

3843. *Platycrinus semifusus* Miller and Gurley 2 Cotypes
3844. Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 77, pl. 4, figs. 41–42, 1895.

3321. *Platycrinus sharonenesis* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 42, pl. 3, figs. 6–7, 1897.

3322. *Platycrinus sulcatus* Miller Holotype and 4 Paratypes
3322a. (See *Platycrinus excavatus* Hall)
Burlington group (Miss.). Sedalia, Missouri.
Miller, Geol. Surv. Missouri, Bull. No. 4, p. 16, pl. 2, fig. 2, 1891.

3323. *Platycrinus sulciferus* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 75, pl. 4, figs. 33–34, 1895.

3324. *Platycrinus tugurium* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 70, pl. 4, figs. 17–19, 1895.

3326. *Platystroma crassa* (James) 2 Cotypes?
(See *Orthis* (*Platystrophia*) *crassa* James)
Maysville (Ord.). Cincinnati, Ohio.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 20, 1874.

3307. *Plectorthis* (*Austinella*) *scovillei* (Miller),
7 Cotypes of S. A. Miller?
(See *Orthis scovillei* Hall & Clarke)

Hudson River group (Ord.). Lebanon, Ohio.
Miller, Jour. Cin. Soc. Nat. Hist., Vol. 5, p. 40, pl. 1, fig. 5, 1882.

3863. *Poteriocrinus altonensis* Miller and Gurley 2 Cotypes
3864. St. Louis (Miss.). Alton, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 62, pl. 4, figs. 3–4, 1895.

3327. *Poteriocrinus blairi* Miller and Gurley Holotype
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 61, pl. 4, figs. 1–2, 1895.

2186. *Poteriocrinus bozemanensis* Miller and Gurley Holotype
Bridger Mts. (Miss.). Bozeman, Montana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 82, pl. 5, figs. 10–11, 1896.

4014. *Poteriocrinus broadheadi* Miller & Gurley 6 Cotypes
4031. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 63, pl. 4, figs. 7–8, 1895.

2187. *Poteriocrinus douglassi* Miller & Gurley Holotype
(=*Decadocrinus douglassi* (Miller and Gurley)
Bridger Mts. (Miss.). Bozeman, Montana.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 10, p. 83, pl. 5, figs. 16–17, 1896.

3402. *Poteriocrinus porrectus* (Miller) Holotype
(See *Scaphiocrinus porrectus* Miller)
Keokuk group (Miss.). Crawfordsville, Indiana.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 652, pl. 7, fig. 2, 1892.

3392. *Poteriocrinus sampsoni* Miller & Gurley
3393. Holotype and 2 Paratypes
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 65, pl. 4, figs. 9–10, 1895.

1474. *Prismatophyllum oweni* Belanski Paratype and Metatype
1472. Shellrock—Nora Substage, Prismatophyllum zonule (Dev.). Rudd, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, No. 5, p. 174, pl. 12, fig. 2, 1928.

1493. *Productella fragilis* Belanski Paratype
Rock Grove Substage—Shellrock, Productella faunule (Dev.), Rudd, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, No. 5, p. 192, pl. 14, figs. 15, 17, 1928.

3942. *Productus blairi* Miller 44 Cotypes
3943. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 689, pl. 13, figs. 16–17, 1892.

1310. *Pterinea cincinnatiensis* Miller and Faber 12 Cotypes
Maysville-Fairmount (Ord.). Cincinnati, Ohio.

Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 25, pl. 1, figs. 11–12, 1894.

3394. *Pterinea rugatula* Miller and Faber 3 Cotypes and 4 Metatypes
3797.
3798. Maysville—Fairmount (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cin. Soc. Nat. Hist., Vol. 17, p. 26, pl. 1, figs. 18–19, 1894.

3329– *Pterinopecten sedaliensis* Miller 16 Cotypes
3329b. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets 17th Rep. Dept. Geol. Nat. Res. Ind., p. 93, pl. 20, figs. 8–9, 1891.

3789. *Ptilodictya* (*Stictopora*) *shafferi* Meek 4 Cotypes
(See *Arthropora shafferi* (Meek))
Maysville—Bellevue, Corryville (Ord.).
Meek, Proc. Acad. Nat. Sci. Phil., p. 317, 1872. Meek, Pal. Ohio Vol. 1, p. 69, pl. 5, figs. 1a-c, 1873.

3971– *Ptychospira plicata* (Miller) 3 Cotypes
3973. (See *Retzia plicata* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 316, pl. 9, figs. 29–31, 1894.

1587. *Rafinesquina minnesotensis* (Winchell) 2 Plasto-plesiotypes
1588. (See *Strophomena deltoidea* Owen)
Plattin, No. 40 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Owen, Geol. Expl. Iowa, Wisconsin and Ill., pl. 16, fig. 8, pl. 17, fig. 6, 1844. C. L. Fenton, Am. Mid. Nat., Vol. 11, No. 3, p. 130, pl. 2, fig. 8, 1928. Walker Museum 25508 and 25512.

3992. *Retzia circularis* Miller 14 Cotypes
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 316, pl. 9, fig. 32–34, 1894.

3971. *Retzia plicata* Miller
3972. (= *Ptychospira plicata* (Miller)) 9 Cotypes
3973. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 316, pl. 9, figs. 29–31, 1894.

3990. *Retzia triangularis* Miller 4 Cotypes
3991. (= *Hustedia triangularis* (Miller))
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 61, pl. 9, figs. 25–26, 1892.

4514. *Rhombotrypa quadrata* Chiro-plesiotype
Thin section
Twitchell, Amer. Mid. Nat., Vol. 15, No. 6, pl. 30, fig. 14, 1934.

3337. *Rhynchotrema increbescens* (Hall) 26 Cotypes
3337a. (See *Rhynchotreta quadriplicata* Miller)
Trenton group (Ord.). Paris, Kentucky.
Miller, N. A. Geol. Pal., p. 370, fig. 608, 1889.

3337. *Rhynchotreta quadriplicata* Miller 26 Cotypes
3337a. (See *Rhynchotrema increbescens* (Hall))
Trenton group (Ord.). Paris, Kentucky.
Miller, N. A. Geol. Pal., p. 370, fig. 608, 1889.

3788. *Rhytimya mickleboroughi* (Whitfield) 2 Cotypes
(= *Orthodesma cymbula* Miller and Faber)
Maysville—Fairmount (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 143, pl. 8, figs. 7–9, 1894.

3338. *Rusophycus montanense* Miller? 2 Cotypes?
Burlington group (Miss.). Bridger Mts., Montana.
Marked types in Miller's collection.

3398. *Saccocrinus marcouensis* Miller 5 Plesiotypes
3399. Niagara group (Sil.). Bridgeport, Illinois.
Miller, Cincinnati Soc. Nat. Hist., Vol. 4, p. 167, pl. 4, figs. 1–1a, July 1881.

799. *Saccocrinus pyriformis* Miller Cotype
(= *Periechocrinus urniformis* (Miller))
(= *Periechocrinus pyriformis* Wachsmuth and Springer)
Niagaran—Racine Dolamite (Sil.). Chicago, Ill.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 5, p. 81, pl. 3, figs. 3, 3a, 1882.

3339. *Scaphiocrinus boonvillensis* Miller Holotype and 18 Paratypes
3339a. Keokuk group (Miss.). Boonville, Miss.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 37, pl. 5, figs. 1–2, 1891.

3402. *Scaphiocrinus porrectus* Miller Holotype and Paratype
3403. (See *Poteriocrinus porrectus* Miller)
Keokuk group (Miss.). Crawfordsville, Ind.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 652, pl. 7, fig. 2, 1892.

3962. *Schizodus sedaliensis* Miller and Gurley Holotype
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 17, pl. 2, fig. 15–16, 1896.

347– *Schizophoria meeki* Fenton and Fenton
350. Allotype and 8 Paratypes
Cedar Valley (Dev.). Profunda zonule? E. of Waverly, Iowa.
Fenton and Fenton, Am. Mid. Nat., Vol. 11, No. 5, p. 160, pl. 11, figs. 3–8, 1928.

3344. *Shumardocrinus concinnus* Miller and Gurley
3344a. Holotype and Paratype
(= *Steganocrinus concinnus* Shumard)
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 41, pl. 2, figs. 7–10, 1895.

3334. *Soleniscus blairi* Miller 2 Paratypes
(See *Macrochilinea blairi* Miller)
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 84, pl. 14, fig. 5, 1891.

3909. *Sphenotus sinuatus* Miller and Gurley 4 Cotypes
3910. Chouteau limestone (Miss.). Sedalia, Missouri.
3911. Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 9, pl. 2, figs. 29–30, 1896.
3345. *Spirifer approximatus erraticus* Belanski 2 Paratypes
1495. *Spirifer cardinalis* Belanski Paratype
Etonia Faunule, Mason City Substage—Shellrock (Dev.). 4 mi. S. E. of Nora Springs, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, p. 201, pl. 16, figs. 23–30, 1928.
3347– *Spirifer varians* 3 Paratypes
3349. *Spirifer varians* Paratype
Spirifer varians Paratype
3350. *Spirifer varians fallox* Paratype
3351. *Spirifer varians flexuosus* 2 Paratypes
3947. *Spirorbis blairi* Miller and Gurley 2 Cotypes
3948. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 89, pl. 5, figs. 14–15, 1895.
3352. *Steganocrinus blairi* Miller and Gurley Holotype
Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12, p. 35, pl. 2, fig. 21–22, 1897.
3344. *Steganocrinus concinnus* Shumard Holotype and Paratype
3344a. (See *Shumardocrinus concinnus* Miller and Gurley)
Burlington group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 41, pl. 2, figs. 7–10, 1895.
3353. *Steganocrinus sharonensis* Miller and Gurley
3353a. Holotype and Paratype
Burlington group (Miss.). Sharon, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 12 p. 32, pl. 2, figs. 10–12, 1897.
3853. *Stephanocrinus hammelli* Miller 2 Cotypes
Clinton—Osgood (Sil.). Near Big Creek P. O., Jefferson County, Indiana.
Miller, 17th Rep. Dept. Geol. and Nat. Res. Ind., p. 635, pl. 6, figs. 7–9, 1892.
3800. *Stephanocrinus osgoodensis* Miller 3 Cotypes
3813. Clinton—Osgood (Sil.). Osgood, Indiana.
3812. Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 2, p. 116, pl. 10, figs. 7–7a, 1879. Miller, 17th Rep. Dept. Geol. Nat. Res. Ind. p. 632, pl. 6, figs. 1–4, 1892.
3944– *Straparollus blairi* Miller 9 Cotypes
3946. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 696, pl. 15, fig. 3, 1892.
3963– *Straparollus missouriensis* Miller and Gurley 15 Cotypes
3965. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 11, p. 20, pl. 2, figs. 35–36, 1896.

812. *Streptelasma corniculum medium* Fenton
828. Paratype and 3 Metatypes
Plattin, No. 26 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, No. 3, p. 128, pl. 2, figs. 5–7, 1928.

1584. *Streptorhynchus neglecta* James 2 Plasto-plesiotypes
1585. (=*Strophomena neglecta* (James))
Richmond (Ord.). Blanchester, Ohio.
James, Paleotologist Vol. 5, p. 41, 1881. Fenton, Am. Mid. Nat. Vol. 11, No. 3–4, p. 157, pl. 8, figs. 8–9, 1928.

1586. *Streptorhynchus* (*Strophomena*) *vetusta*, James Plast-plesiotype
(=*Strophomena vetusta* (James))
Richmond (Ord.). Blanchester, Ohio.
James, Cin. Quart. Jour. Sci. Vol. 1, p. 241, 1874. Fenton, Am. Mid. Nat. Vol. 11, No. 3–4, p. 156, pl. 9, figs. 9–11, 1928.
Walker Museum 25545.

1499. *Stropheodonta cicatricosa* Belanski Paratype
Camarophoria Faunule, Mason City Substage—Shellrock (Dev.). Nora Springs, Iowa.
Belanski, Am. Mid. Nat., Vol. 11, No. 4, p. 189, pl. 14, figs. 11–14, 1928.

1573– *Strophomena auburnensis* Fenton Plasto-holotype,
1576. 2 Plasto-paratypes,
2 Plasto-allotypes
Auburn chert (Ord.). Auburn, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, No. 3–4, p. 148, pl. 9, figs. 1–3, 1928 May–July.
Walker Museum 25522, 25523, 25521, respectively.

1577. *Strophomena delicatula* Fenton
800. Plasto-holotype and Plasto-paratype
Decorah (Ord.). 2½ mi. w. of Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 155, pl. 9, figs. 4–6, 1928.
Walker Museum 25537 and 25538.

1578. *Strophomena delicatula* Fenton 2 Plasto-allotypes
Decorah (Ord.). 2½ mi. w. of Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 155, pl. 9, figs. 4-6, 1928.
Walker Museum 33400.

1587. *Strophomena deltoidea* Owen 2 Plasto-plesiotypes
(=*Ranfiesquina minnesotensis* (Winchell))
Plattin No. 40 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Owen, Geol. Expl. Iowa, Wisconsin & Illinois, pl. 16, fig. 8, pl. 17, fig. 6, 1844. Fenton, Am. Mid. Nat. Vol. 11, p. 130, pl. 2, fig. 8, 1928.
Walker Museum 25508 and 25512.

1588. *Strophomena deltoidea* Owen Plasto-plesiotype
(= *Rafinesquina minnesotensis* (Winchell))
Upper Plattin (Ord.). Gabouri Creek, near Ste. Genevieve, Mo.
Owen, Geol. Expl. Iowa, Wisconsin and Illinois, pl. 16, fig. 8, pl. 17, fig. 6, 1844.

1580. *Strophomena dignata* Fenton Plasto-paratype, Plasto-holotype
1581. and 2 Plasto-allotypes
1594. Decorah (Ord.). 2½ mi. w. of Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 151, pl. 10, figs. 3–5, 1928.
Walker Museum 25532, 25533, 25535, respectively.

1582. *Strophomena exigua* Fenton Plasto-holotype and Plasto-
1583. paratype
Plattin No. 41 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat. Vol. 11, Nos. 3–5, p. 152, pl. 10, fig. 6, 1928.
Walker Museum 25956, 25957.

4752– *Strophomena filitexta* Meek 5 Plasto-cotypes
4755. (See *Strophomena neglecta* (James))
Black River (Ord.). Middleville, New York.
Meek, Pal. Ohio, Vol. 1, p. 83, pl. 6, fig. 5, 1873. Amer. Museum Natural History $\frac{702}{1}$

1570. *Strophomena inconsueta* Fenton 2 Plasto-holotypes and
1571. Plasto-paratype
Plattin No. 16 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 154, pl. 10, fig. 2, 1928.
Walker Museum 25987, 25989.

1567– *Strophomena musculosa* Fenton Plasto-holotype, 2 Plasto-
1569. allotypes and 2 Plasto-paratypes
1572. Decorah (Ord.). Fountain, Minn.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 153, pl. 8, fig. 6–7, 1928.
Walker Museum, 25524, 25525, 25527.

4752– *Strophomena neglecta* (James) 5 Plasto-cotypes
4755. (See *Strophomena filitexta* Meek)
Black River (Ord.). Middleville, New York.
Foerste, Bull. Sci. Lab. Denison Univ., Vol. 17, pl. 5, figs. 1, 3; pl. 7, fig. 5; pl. 9, fig. 1; pl. 11, fig. 10; 1912.
Meek, Pal. Ohio, Vol. 1, p. 83, pl. 6, fig. 5, 1873.

1584. *Strophomena neglecta* (James) 2 Plasto-plesiotypes
1585. (See *Streptorhynchus neglecta* James)
Richmond (Ord.). Blanchester, Ohio.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 157, pl. 8, figs. 8, 9, 1928.

James, Pal. Vol. 5, p. 41, 1881.
Walker Museum 25544.

1562– *Strophomena plattinensis* Fenton — Plasto-allotype, 4 Plasto-
1566. paratypes and Plasto-holotype
1595. Plattin, No. 41 (Ord.). S. Beckett Hill, Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 149, pl. 10, figs. 7–9, 1928.
Walker Museum 25983, 25501, 25514, 25988.

1586. *Strophomena vetusta* (James) — Plasto-plesiotype
(See *Streptorhynchus* (*Strophomena*) *vetusta* James)
Upper Plattin (Ord.). Gabouri Creek, near Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 156, pl. 9, figs. 9–11, 1928.
Walker Museum 25545.

1589. *Strophomena winchelli* Hall and Clarke — Plasto-plesiotype
Upper Plattin (Ord.). Gabouri Creek, near Ste. Genevieve County, Missouri.
Fenton, Am. Mid. Nat., Vol. 11, Nos. 3–4, p. 150, pl. 9, fig. 8, 1928.
Walker Museum 25513.

3355. *Strotocrinus blairi* Miller and Gurley — Holotype
Burlington Group (Miss.). Sedalia, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 48, pl. 2, fig. 24, 1895.

3356. *Strotocrinus ornatus* Miller and Gurley — Holotype
Burlington group (Miss). Burlington, Iowa.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 30, pl. 2, figs. 12–14, 1896.

3848. *Synbathocrinus illinoisensis* Miller and Gurley
3849. Holotype and 6 Cotypes
Burlington group (Miss.). Adams County, Illinois.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 8, p. 53, pl. 3, figs. 29–31, 1896.

3886. *Technophorus cincinnatiensis* Miller and Faber — Holotype
Eden—Economy (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 17, p. 147, pl. 8, figs. 15–16, 1894.

3987– *Terebratula occidentalis* Miller — 3 Cotypes
3989. (See *Dielasma occidentalis* (Miller))
Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, Adv. Sheets, 18th Rep. Dept. Geol. Nat. Res. Ind., p. 59, pl. 9, figs. 10–13, 1893.

3357. *Trigonia stiebeli* Miller — Holotype
(Cretaceous.). S. E. Arizona.
Miller, Jour. Cincinnati Soc. Nat. Hist., Vol. 4, p. 259, pl. 6, fig. 1, Oct. 1881.

3358. *Troostocrinus neglectus* Miller — Holotype?
St. Louis group (Miss.). Washington County, Indiana.

3194-1. *Whipplella cuneiformis* Holland Paratype
Nineveh limestone (Permian).
Limestone Hill, Wood County, West Virginia. Holland, Ann. of Carnegie Mus., Vol. 22, p. 344, pl. 25, fig. 5, 1934.

3194-2. *Whipplella depressa* Holland Paratype
Nineveh limestone (Permian)
Limestone Hill, Wood County, West Virginia.
Holland, Am. of Carnegie Mus., Vol. 22, p. 345, pl. 25, fig. 7, 1934.

3194-3. *Whipplella magnitata* Holland Paratype
Nineveh limestone (Permian). Nineveh, Greene County, Pennsylvania.
Holland, Ann. of Carnegie Mus., Vol. 22, p. 346, pl. 25, fig. 2, 1934.

3194-6. *Whipplella ninevehensis* Holland Paratype
Nineveh limestone (Permian). Nineveh, Greene County, Pennsylvania.
Holland, Ann. of Carnegie Mus., Vol. 22, p. 347, pl. 25, fig. 3, 1934.

3194-4. *Whipplella ovata* Holland Paratype
Nineveh limestone (Permian). Nineveh, Greene County, Pennsylvania.
Holland, Ann. of Carnegie Mus., Vol. 22, pl. 25, fig. 4, p. 348, 1934.

3194-5. *Whipplella parvula* Holland Paratype
Nineveh limestone (Permian). Nineveh, Greene County, Pennsylvania.
Holland, Ann. of Carnegie Mus., Vol. 22, pl. 25, fig. 6, p. 347, 1934.

3786. *Whiteavesia corrugata* (Miller and Faber) 5 Cotypes
(See *Modiolopsis corrugata* Miller and Faber)
Maysville—Corryville (Ord.). Cincinnati, Ohio.
Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., Vol. 15, p. 79, pl. 1, fig. 11, 1892.

3790. *Whiteavesia pholadiformis* (Hall) Plesiotype
(See *Modiolopsis pholadiformis* Hall)
Richmond (Ord.). Richmond, Indiana.
Miller, Cincinnati Quart. Jour. Sci., Vol. 1, p. 282, 1874.

3362. *Woodocrinus pocillum* (Miller) 14 Paratypes?
(See *Zeacrinus pocillum* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Bull. Geol. Surv. Mo., No. 4, p. 28, pl. 4, figs. 1-2, 1891.

3359. *Zaphrentis calyculus* Miller 56 Cotypes
3359a. Chouteau limestone (Miss.). Pettis County, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 620, pl. 1, figs. 13-14, 1892.

3916. *Zaphrentis chouteauensis* Miller 17 Cotypes
3917. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 620, pl. 1, figs. 11-12, 1892.

3940. *Zaphrentis tantilla* Miller 32 Cotypes
3941. Chouteau limestone (Miss.). Sedalia, Missouri.
Miller, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 621, pl. 1, Figs. 23–24, 1892.

3360. *Zaphrentis tenella* Miller Holotype and 32 Paratypes
3360a. Chouteau limstone (Miss.). Sedalia, Pettis County, Missouri.
Miller, Adv. Sheets, 17th Rep. Dept. Geol. Nat. Res. Ind., p. 11, pl. 1, figs. 17–18, 1891.

3861. *Zeacrinus blairi* Miller and Gurley Holotype
Keokuk group (Miss.). Boonville, Missouri.
Miller and Gurley, Ill. State Mus. Nat. Hist., Bull. No. 7, p. 66, pl. 4, figs. 5–6, 1895.

3361. *Zeacrinus commaticus* Miller 44 Paratypes?
Keokuk group (Miss.). Boonville, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 36, pl. 5, figs. 10–11, 1891.

3362. *Zeacrinus pocillum* Miller 14 Paratypes?
(See *Woodocrinus pocillum* Miller)
Keokuk group (Miss.). Boonville, Missouri.
Miller, Geol. Surv. Mo., Bull. No. 4, p. 28, 1891.

Pollen

In recent years there has been increasing interest taken in pollen. This has been in part due to the effects of pollen grains on hayfever sufferers, and in part to the fact that the more resistant pollen grains are often well preserved in peats and other natural deposits where the other remains are so changed as to be unrecognizable. The investigations of peats are going on all over the world, especially in regions which were glaciated in the Pleistocene, and from these studies we are learning much about past plant assembleges and distributions as well as past climates. Wodehouse in his new book "Pollen Grains" discusses the history of pollen studies, pollen not having been seen in detail until 1665 altho known to exist as a sort of dust. Methods of collecting and preparing fresh pollens for study are given. A chapter by G. Erdtman takes up fossil pollens and "Pollen Statistics." A discussion of atmospheric pollen leads naturally to hayfever. Then follows a discussion of characters of pollen grains. The major part of the book is devoted to a classification of pollen grains. A master key takes some 8 pages. The classification begins with the fossil pollens of the Cycadofilicales with some 11 different pollen grains described. The Cordaitales and Bennettitales are also included. The living Gymnosperms are next, covering 84 pages. The Angiosperms fill the rest of the book. A glossary, bibliography and index close the book.

This excellent classification of pollen grains should find a wide open field. Certainly botantists need it as well as all paleobotantists who are working on the younger rocks. As far as I know it is the only book bringing together descriptions of pollen grains. Its value is increased by the numerous careful illustrations. My only regret is that it could not tell us more about the fossil pollen grains, many of which require an especial technique to free them from the rocks or coal where they are preserved.—Willard Berry.

Pollen Grains, by R. P. Wodehouse. xvi+574 pp. New York, The McGraw-Hill Book Co. 1935.

STUDIES IN NOCTURNAL ECOLOGY, V.

An Experiment in Conducting Field Classes at Night[1]

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and
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The chief purpose of this report is to suggest the value of incorporating night field trips into the regular schedule of classes in Animal Ecology. This is predicated upon the belief that instruction should reflect the gains made by research in any given field. Secondly, since the data taken are of interest, a part are given here as they add to our meager store of information upon nocturnal animals, the importance of which has been cited previously by Allee (1927).

METHOD

The locality chosen was a climax beech-sugar maple-wood frog association in northern Indiana. The authors were familiar with the forest in both the nocturnal and diurnal phase, the area having been studied irregularly since 1927. Preliminary details were arranged in the afternoon before regular class work had started. In this work white paint, strips of white cloth or paper squares were used to mark out a series of trails. Following the methods employed earlier (Park, Lockett and Myers, 1931), appropriate observation stations were established, e. g. logs and stumps, usually well decayed and bearing a variety of fungi, Mycetozoa, et cetera. When establishing the trails, any animals which could be observed without destruction of their habitat niches, were marked with paint. For this purpose a fast-drying mixture was made up by dissolving aluminum base in banana oil (Baer's Klondike Paint).

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[1]It is with pleasure we acknowledge the enthusiasm of the students co-operating in this joint field trip between the classes in Animal Ecology of the two Universities; our indebtedness to Professor W. C. Allee for criticism throughout the conception of the project; and to the many specialists who, by their presence in the field, made subsequent identification of animals possible, e. g., W. J. Gerhard (Hemiptera), Emil Liljeblad (Coleoptera), D. C. Lowrie (Araneida). C. H. Seevers (Coleoptera), Mary Talbot (Formicidae), R. L. Wenzel (Coleoptera) and A. B. Wolcott (Cleridae).

After these preliminaries were completed the group was divided into two observation units of ten to twelve students each and examination of the stations was begun shortly after dusk. The trails were run alternately by each group hourly, until shortly after dawn. Both gasoline lantern and electric torches were used, and full notes taken as to kind of animal, number to be observed at a station, position and activity (feeding, walking, copulating), and time of observation for each station throughout the night. Simultaneously with the running of the trails physical data were also compiled, viz. light intensity, air and soil temperature, rate of evaporation and relative humidity.

RESULTS

Since most of the data taken show at least an apparent correlation with the periodic change in the physical influences measured, the light intensity during dusk and dawn is given in tabular form (Table I). The more commonly measured influences (temperature, relative humidity, evaporation rate)

TABLE I

LIGHT INTENSITY IN FOOT CANDLES

(Weston Illuminometer: May 25–May 26)

DUSK			
Unobstructed Sky		*Under Forest Canopy*	
5:15 P. M.	4000	5:10 P. M.	600
5:30 "	3200	5:25 "	450
5:45 "	3000	5:40 "	400
6:00 "	2400	5:55 "	400
6:15 "	2000	6:10 "	300
6:30 "	1800	6:25 "	280
6:45 "	1200	6:40 "	120
7:00 "	400	6:55 "	72
7:15 "	400	7:10 "	54
7:55 "	84	8:00 "	12
8:20 "	6	8:25 "	0
DAWN			
4:45 A. M.	2	4:55 A. M.	0
5:00 "	4	5:10 "	1
5:02 "	6	5:13 "	2
5:04 "	8	5:23 "	6
5:05 "	10		
5:06 "	12		
5:16 "	34		
5:18 "	40		
5:19 "	46		
5:20 "	50		
5:45 "	400		
6:30 "	620		

(Central Daylight Saving Time)

are intimately associated with the fall and rise in illumination, and as they have been discussed previously (Park, *et al.*, *loc. cit.*) in nocturnal work, need no further elaboration. With respect to these physical measurements, however, it should be kept in mind that in the case of species in which an inherent nocturnal activity has been demonstrated, the releasing stimulus is not a direct consequence of the operative nocturnal influences, or if it is then the elucidation awaits further experimentation.

With respect to the animals observed, little attempt was made to mark or take data upon those forms which could not be determined with precision in the field, or which could not be certainly identified later from collections made for this specific purpose. Despite this necessary limitation of the group's work, the number of species discerned to be active during the night proved surprisingly large. Some few forms were out in relatively great numbers, and these are treated in detail later; however, since lists of nocturnally active animals are so few in comparison with the diurnal fauna, the following table (Table II) gives the species which were positively identified and found to be active during the night, that is, in activity away from their diurnal niches of concealment.

TABLE II

NOCTURNAL CONSTITUENTS OF THE CLIMAX FOREST

ANIMAL OBSERVED	WHERE ACTIVE	BIBLIOGRAPHIC CITATION RELEVANT TO SPECIES NOCTURNALISM
RODENTIA:		
Peromyscus leucopus noveboracensis	Floor	Johnson, 1926
HYMENOPTERA:		
Formicidae	Log and Stump	Flint, 1914
Lasius niger americanus		McCook, 1877
Aphaenogaster fulva picea		Park, Lockett and Myers, 1931
Aphaenogaster tenneeseensis		
Camponotus caryae		
Camponotus herculeanus pennsylvanicus		
COLEOPTERA:		
Carabidae	Floor, Log and Stump	Champlain & Kirk, 1910
Pterostichus adoxus		Chapman, et al, 1926
Calathus gregarius		Floersheim, 1906
Galerita janus		Garnett, 1920
Pinacodera limbata		Kirchner, 1927
Chlaenius aestivus		Oertel, 1924
		Park, et al, 1931
		Scott, 1932
		Seeman, 1928

TABLE II—(Continued)
NOCTURNAL CONSTITUENTS OF THE CLIMAX FOREST

ANIMAL OBSERVED	WHERE ACTIVE	BIBLIOGRAPHIC CITATION RELEVANT TO SPECIES NOCTURNALISM
COLEOPTERA—(Continued:)		
Staphylinidae	Cut Stump Surfaces	Park, et al, 1931
Conosoma crassum		
Erchomus ventriculus		
Erotylidae	Fomes applanatus	Park, et al, 1931
Megalodacne heros	(Feeding and copulating)	Park and Sejba, 1935
Nitidulidae	Fungi, Sugaring solution and plasmodia	Park, et al, 1931
Glischrochilus fasciatus		
Glischrochilus sanguintolentus		
Cucujiidae	Stump surfaces and plasmodia	
Brontes dubius		
Laemophlaeus fasciatus		
Laemophlaeus testaceus		
Temnochilidae	Logs and Stumps; Fungi and plasmodia	
Tenebroides corticalis		
Tenebroides laticollis		
Cleridae	Stacked Wood	
Enoclerus nigripes		
Cisidae	Fungi	
Cis fuscipes		
Elateridae	Logs and Stumps	
Melanotus communis		
Melanotus decumanus		
Tenebrionidae	Logs and Stumps	Park, et al, 1931
Alobates pennsylvanica	Fomes applanatus	Park and Keller, 1932
Boletotherus cornutus	(Feeding and copulating)	
Diaperis maculata	Fungi	
Hoplocephala bicornis	Fungi	
Melandryidae		Park, et al, 1931
Melanodrya striata	Cut log surfaces	
Penthe obliquata	Fungi	
Penthe pimelia	Fungi	
Scarabaeidae		
Cleotus aphodiodes	Stacked Wood	
Phyllophaga species	Feeding on foliage of shrub stratum	Davis, 1916
Serica sericea		Forbes, 1907, 1916
Serica parallela	Feeding on foliage of shrub stratum	Sanders and Fracker, 1916
		Schwarz, 1893
Cerambycidae		
Leptostylus aculifer	Stacked Wood	
HETEROPTERA:		
Aradidae	Logs and Stumps, Fungi	
Aradus crenatus		
Aradus implanus		
Aradus quadrilineatus		
Pentatomidae		
Menecles insertus	Foliage and bark of shrub and tree strata	

TABLE II—(Continued)

NOCTURNAL CONSTITUENTS OF THE CLIMAX FOREST

ANIMAL OBSERVED	WHERE ACTIVE	BIBLIOGRAPHIC CITATION RELEVANT TO SPECIES NOCTURNALISM
ORTHOPTERA:		Allard, 1930
Ceuthophilus latens	Floor	Haber, 1920
Parcoblatta pennsylvanica	Logs and Stumps	Lutz, 1932
		Park and Keller, 1932
		Park, et al, 1931
		Rockwood, 1925
		Turner, 1915
LEPIDOPTERA:		Balfour-Brown,
Noctuid larvae and adults	Log and Stump, at sugaring solutions	1925, 1933
		Brower, 1930
		Rau and Rau, 1929
		Stanley, 1932
DIPLOPODA:		
Spirobolus marginatus	Log and Stump	Park, 1935
		Park, et al, 1931
GASTROPODA:	Log and Stump	Allard, 1931
Agriolimax campestris		Boycott, 1934, p. 9
Anguispira alternata		Park, et al, 1931
		Van Cleave, 1931
ARANEIDA:		
Dictynidae		
Amaurobius bennetti	In web	
Clubionidae	Logs and Stumps	
Clubiona riparia		
Clubiona pallens	Copulating 1:00 A.M.	
Thomisidae		
Xysticus ferox	Logs and Stumps	
Agalenidae		
Coras medicinalis	Logs and Stumps	
Pisauridae		
Dolomedes tenebrosus	Logs and Stumps	
Lycosidae		
Schizocosa crassipes	Logs and Floor	
Attidae		
Wala mitrata	Herbaceous Stratum	

The above list of some fifty species represents but a small portion of the animals found active during the night, and does not include the abundant phalangids, centipedes *et cetera* remaining undetermined. It will be noted that these forms found usually under bark and mold during the day are nocturnal constituents of the community. In these species, three phyla (Mollusca, Arthropoda, Chordata) are represented and the greatest number of species are found in the largest group, the arthropods, and particularly in the largest order, the beetles.

Promptly at dusk the majority of the nocturnal forms moved out of their diurnal hibitat niches, e. g. log and leaf mold chiefly, and began their nightly activity. The myceto-phagous forms (Erotylidae, Nitidulidae, Cucujiidae, Temno-chilidae, Tenebrionidae, Melandryidae) were to be observed feeding upon the bracket and other fungi, as well as on the plasmodia of Mycetozoa and in some cases on the sap exudates and artificially prepared sugaring solutions smeared on certain stumps and trees; carnivorous forms (Carabidae, Staphylinidae, Araneida) began their nightly hunt for prey, while the herbi-vores left the leaf mold at the tree bases and in the mold to ascend the tree trunks and feed on foliage of shrub and tree stratum (Pentatomidae, Serica and Phyllophaga, *et al*). The pentatomid, *Menecles insertus*, proved especially instructive by illustrating the principle of vertical migration. By 9:10 P. M. these bugs were crawling from beneath the leaf mold at the bases of stump and tree and beginning their night ascent into higher strata. They appeared in great numbers throughout the night, and by midnight were from eight to fifteen feet or more up on the tree trunks and foliage. By 3:20 A. M. the pentatomids were moving down the trunks, and this downward movement continued until by 4:23 A. M. they were on the average from six to eight feet above the floor. At 5:00 A. M. the stragglers were two to four feet from the floor, but the majority had crawled once more under the floor mold and debris.

The data with respect to *Menecles insertus* checks with similar findings of Sanders and Shelford (1922) who showed similar vertical movements up and down of diurnal species during the day, and these results are also perfectly compatible with the fluctuations in numbers of nocturnal constituents as previously demonstrated by Chapman, *et al* (1926), Park *et al* (1931), Park and Keller (1932), Park and Sejba (1935) and Carpenter (1935). To illustrate this general, sustained noc-turnal activity, Table III (*see* page 52) has been prepared.

The data shown represents the numbers of active individuals of several typical animals as observed by the unit making the trails at a given time, and consequently represent *indices* of activity rather than a quantitative estimate of such activity as has been demonstrated in work with *Megalodacne heros* under rigid experimental and field conditions (Park and Sejba, 1935). For this reason they understate the activity, since

many individuals undoubtedly escaped observation, or were adversely stimulated by the approaching lights and sought temporary cover.

TABLE III

ACTIVITY OF REPRESENTATIVE NOCTURNAL ANIMALS

Time	Number of Individuals Discerned to be Active from the First Evening Record to the Last Observed Record Before Retiring. Marked Animals				
	Parcoblatta pennsylvanica	*Ceuthophilus latens*	*Spirobolus marginatus*	*Polygyra thyroides*	*Anguispira alternata*
(First Trip):					
9:00 P. M.	1				
9:20 "	1				
9:25 "	1	1	2		1
9:35 "			1		
9:40 "	1		1		
9:45 "	1		1		
9:47 "			1		
9:50 "		5	1	1	
(Second Trip):					
10:40 P. M.	1				
10:50 "			1	1	
11:00 "		1			1
11:15 "		1	4		
11:25 "			1	4	1
11:30 "			1	1	
11:35 "	1	1	6		
(Third Trip):					
2:01 A. M.		1			
2:09 "	2				
2:12 "			2	1	
2:17 "				1	
2:19 "	1				
2:21 "					1
2:25 "			2		
2:30 "			1	1	1
2:33 "	1				
2:37 "				2	
2:38 "			1		
2:40 "			1	2	
2:42 "			1		
2:52 "			4	1	
2:54 "	1	1	3		1
3:00 "			1	4	
(Fourth Trip):					
3:25 A. M.			1		
3:30 "			1		
3:45 "			1	1	1
4:05 "			1		
4:35 "			1		
(Fifth Trip): (Dawn)					
4:50 A. M.			1	1	1
5:00 "		2			1

The same general activity may be shown for many other forms, for example the pentatomids, *Menecles insertus*, the spiders, which were active from the first trip (9:00 P. M. to 4:15 A. M.), and for the spotted slug, *Philomycus carolinensis*. The latter gave probably the most abundant and typical picture of nocturnal activity, since the individuals were constantly active in numbers from 9:25 P. M. to 5:05 A. M.; however, the marking of individuals failed as the slugs secreted mucous after being marked and in a few minutes the paint had been swept off of the animal.

Finally, the copulation of many species was observed, in particular in *Boletotherus cornutus*, *Megalodacne heros* and *Clubiona pallens* Hentz.

SUMMARY

Night field work, in courses dealing with the ecology of animals, has been demonstrated to work efficiently, and a provisional plan of operation is given. In night trips emphasis is placed upon certain important features which otherwise would remain unknown, or but vaguely realized, namely, (1) the large and varied number of nocturnal animals, both as to species and individuals, (2) the distinctness or integrity of these nocturnal forms, (3) the phenomenon of vertical movements (inter-, and intra-stratal), (4) the quiescent or sleeping diurnal constituents, and (5) the lack of knowledge concerning the nocturnal fauna, and hence the opportunity for effective research.

The data taken may be summarized as follows: light intensity through dusk and dawn are given in foot-candles; an extensive list of species found active is presented, together with place of activity and relevant bibliographic citations; the abundant and typical forms are dealt with in a table which demonstrates their sustained nocturnal activity, and the vertical migration of the pentatomid bug, *Menecles insertus*, is described.

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THE DESMIDS OF FLORIDA

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The desmids of Florida have never been specially studied, although algologists have listed some of the numerous species from time to time since Bailey (1851, 1855) gave the first known account. Wolle (1892) lists 92 desmids from Florida either found by him or previously reported by Wood or Bailey. Johnson (1894, 1895) reports a few additional species and varieties from the state. The most comprehensive list published to date is that of Borge (1909), who lists one hundred and eight species, varieties, and forms for the state.

The list in the present paper consists of a hundred and forty species, varieties, and forms which have been collected by the writer and identified during the summer quarters of 1932 to 1934 at the Ohio State University. Of these sixty-one are new records for the state.

Collecting has been done in August, December, and April. The desmid flora shows marked seasonal variations, so that to secure a fairly complete knowledge of all the species it will be necessary to make collections throughout the year.

The writer wishes to express his appreciation to those who have aided him so materially in this study, especially to Dr. L. H. Tiffany, E. H. Ahlstrom, and C. E. Taft of the Botany Department of the Ohio State University.

The list of species follows, arranged in the order commonly used by workers on desmids.

**Gonatozygon aculeatum* var. *gracile* Grönblad.
* " *pilosum* Wolle.
Netrium digitus (Ehrenberg) Itzigsohn & Rothe.
* " *interruptum* (Brébisson) Luetkemueller.
Penium libelulla var. *interruptum* W. & G. S. West.
" *minutum* f. *major* Lundell.
Closterium archerianum Cleve.
* " *attenuatum* Ehrenberg.
* " *costatum* Corda.
* " *didymotocum* Corda.
* " *kuetzingii* Brébisson.
* " *leibleinni* Kuetzing.

*New record for Florida.

**Closterium pritchardianum* Archer.
* " *ralfsii* var. *hybridum* Rabenhorst.
* " *regulare* Brébisson.
" *setaceum* Ehrenberg.
" *venus* Kuetzing.
Docidium undulatum Bailey.
Pleurotaenium nodosum (Bailey) Lundell.
" *trochiscum* W. & G. S. West.
Tetmemorus brebissonii (Meneghini) Ralfs.
**Euastrum ansatum* Ralfs.
* " *attenuatum* Wolle.
" *evolutum* W. & G. S. West.
" *humerosum* Ralfs.
" *insigne* Hassall.
**Netrium intermedium* Cleve.
" *oblongum* (Greville) Ralfs.
" *pinnatum* Ralfs.
" *ventricosum* Lundell.
" *verrucosum* Ehrenberg.
* " *verrucosum* var. *planctonicum* W. & G. S. West.
* " *wollei* Lagerheim.
**Micrasterias abrupta* W. & G. S. West.
* " *alata* Wallich.
" *americana* (Ehrenberg) Ralfs.
" *apiculata* var. *fimbriata* (Ralfs) Nordstedt.
* " *apiculata* var. *fimbriata* f. *spinosa* Bissett.
" *arcuata* var. *gracilis* W. & G. S. West.
" *arcuata* var. *expansa* (Bailey) Nordstedt.
* " *arcuata* f. *intermedia* Nordstedt.
* " *conferta* Lundell.
* " *conferta* var. *hamata* Wolle.
" *denticulata* Brébisson.
" *depauperata* var. *kitchelli* (Wolle) W. & G. S. West.
* " *floridensis* n. sp.
" *foliacea* Bailey.
* " *jenneri* Ralfs.
" *laticeps* Nordstedt.
" *mahabuleshwarensis* Hobson.
* " *muricata* (Bailey) Ralfs.
* " *murrayi* W. & G. S. West.
" *pinnatifida* (Kuetzing) Ralfs.
Micrasterias radiata Hassall.
* " *ranoides* n. sp.
" *ringens* var. *serrulata* Wolle.
" *sol* (Ehrenberg) Kuetzing.
* " *sol* var. *ornata* Nordstedt.
* " *sol* var. *swainii* (Hastings) W. & G. S. West.
* " *torreyi* Bailey.
" *truncata* (Corda) Brébisson.

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*New record for Florida.

Cosmarium amoenum Brébisson.
* " *brebissonii* Meneghini.
" *commissurale* Brébisson.
" *connatum* Brébisson.
" *granatum* Brébisson.
* " *isthmium* W. West.
* " *ochthodes* Nordstedt.
" *ornatum* Ralfs.
* " *orthogonum* Delponte.
* " *ovale* Ralfs.
* " *ovale* var. *subglabrum* W. & G. S. West.
" *portianum* Archer.
" *pyramidatum* Brébisson.
* " *regnesi* Reinsch.
* " *usmense* Skuja.
Xanthidium antilopaeum Kuetzing.
" *antilopaeum* var. *minneapoliense* Wolle.
" *antilopaeum* var. *polymazum* Nordstedt.
* " *antilopaeum* var. *triquetrum* Lundell.
Xanthidium armatum var. *cervicorne* W. & G. S. West.
" *cristatum* Brébisson.
" *subhastiferum* W. West.
Arthrodesmus convergens Ehrenberg.
" *incus* var. *longispinus* Eichler & Raciborski.
" *octocornis* Ehrenberg.
**Staurastrum arcuatum* Nordstedt.
* " *arctiscon* var. *glabrum* W. & G. S. West.
" *brachiatum* Ralfs.
" *brasiliense* var. *lundellii* W. & G. S. West.
* " *brevispinum* f. *major* W. & G. S. West.
* " *curvatum* var. *elongatum* G. M. Smith.
" *dickiei* var. *maximum* W. & G. S. West.
" *grallatorium* var. *forcipigerum* Lagerheim.
* " *limneticum* var. *cornutum* G. M. Smith.
" *leptocladum* Nordstedt.
* " *minnesotense* Wolle.
* " *muticum* var. *minor* Wolle.
* " *ophiura* Lundell.
* " *ornithopodum* W. & G. S. West.
" *paradoxum* var. *osceolense* Wolle.
" *quadrangulare* var. *armatum* W. & G. S. West.
" *quadrispinatum* Turner.
* " *radians* W. & G. S. West.
" *rotula* Nordstedt.
" *setigerum* Cleve.
* " *spiculiferum* G. M. Smith.
* " *spongiosum* Brébisson.
" *tohopekaligense* Wolle.
" *trifidum* var. *inflexum* W. & G. S. West.

*New record for Florida.

**Staurastrum vestitum* Ralfs.
* " *vestitum* var. *semivestitum* W. West.
* " *wolleanum* var. *intermedium* W. & G. S. West.
Sphaerozosma excavatum Ralfs.
" *vertebratum* f. *minor* W. West.
Onychonema laeve Nordstedt.
" *laeve* var. *micracanthum* Nordstedt.
* " *filiforme* (Ehrenberg) Roy & Bissett.
Spondylosium planum (Wolle) W. & G. S. West.
" *pulchrum* (Bailey) Archer.
Hyalotheca dissiliens (Smith) Brébisson.
" *mucosa* (Dillwyn) Ehrenberg.
* " *neglecta* Raciborski.
Desmidium aptogonum Brébisson.
* " *aptogonum* var. *ehrenbergii* Kuetzing.
" *baileyi* (Ralfs) Nordstedt.
" *coarctatum* Nordstedt.
" *cylindricum* Greville.
* " *gracileps* (Nordstedt) Lagerheim.
" *quadratum* Nordstedt.
" *swartzii* Agardh.
" *swartzii* var. *quadrangulare* (Ralfs) Roy.
Gymnozyga moniliformis Ehrenberg.
* " *delicatissima*.
Phymatodocis nordstedtiana Wolle.
* " *nordstedtiana* var. *minor* Borgesen.
Triploceras gracile Bailey.
" *verticillatum* Bailey.
**Mateola acutiloba* n. gen. et sp.

Micrasterias alata Wallich.

The first record for the United States, although Lagerheim reported it for Cuba.

Micrasterias floridensis n. sp. (Pl. I, Fig. 2.)

Cells large, about as long as broad, suboctangular, deeply constricted, sinus linear. Semicells five-lobed, interlobular incisions narrowly linear; polar lobe cuneate, with dilated truncate apex, not projecting beyond the lateral lobes; lateral lobes almost equal and cuneate, divided into two lobules by a V-shaped incision; each lobule bifurcate into short spines. Vertical view fusiform. Cell wall finely punctate.

Zygospore unknown.

Length, 224–228μ; breadth 207–224μ; breadth of isthmus 21–22.5μ; polar lobe at apex 76–86μ.

Habitat: Keystone Lake near Odessa, Florida.

Micrasterias foliacea Bailey. (Pl. I, Fig. 7.)

M. foliacea Bailey occurs abundantly around Riverview and Childs. Cells with a zygospore were found at Riverview, April, 1933.

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*New record for Florida.

Zygospore ovoid with stout bi- or trifurcate spines. Length of zygospore without spines 52μ; thickness 38μ; length of spines 17–21μ.

Turner (1893) figures the zygospore of the species and Krieger (1932) figured the zygospore of the var. *ornata*. The latter differs so markedly from the zygospore of *foliacea* vera that one is led to conclude that it either should be made a distinct species, or else that Krieger did not have the zygospore of the variety.

Micrasterias piquata n. sp. (Pl. I, Figs. 3–5.)

Cells small, about 1½ times as long as broad, subrectangular with broadly truncate poles, deeply constricted, sinus slightly open; semicells three lobed, incisions below polar lobe shallow and open; polar lobe broad with apex slightly convex and terminating in two (rarely one) laterally extending short spines, lateral lobes subrectangular, with two (sometimes one) short parallel spines at each corner. Vertical view of semicell broadly oval.

Zygospore unknown.

Length, 100–111μ; breadth, 83–96μ; thickness, 37μ; breadth of isthmus, 17–19μ.

Habitat: Pond 6 miles south of Riverview.

Micrasterias ranoides n. sp. (Pl. I, Fig. 1.)

Cells large, a little longer than broad, circular, deeply constricted, sinus open; semicells 5-lobed with deep, fairly open interlobular incisions; polar lobe cuneate with apical margin retuse with the lateral margins drawn into spines at each corner. Lateral lobes equal and cuneate, each divided into lobules by a wide open sinus about half as deep as the interlobular sinus; each lobule drawn into two long diverging spines. Side view of cell fusiform with polar lobe about half as thick as cell. Cell wall smooth.

Zygospore unknown.

Length, 208–269μ; breadth, 202–259μ; breadth of isthmus, 21–23μ; length of polar lobe, 102–118μ; thickness, 45–50μ; breadth of polar lobe at base, 19–20μ; at apex, 74–79μ; length of spines, 20–25μ.

Habitat: Keystone Lake near Odessa, Fla.; Okeechobee, Fla.

Micrasterias radiata Hassall.

Many varieties have been given for this species, but as they do not appear to be distinct they cannot be maintained. The lateral lobes may be very narrow as in *M. dichotoma* Wolle. They may be reduced in number as in the variety *simplex* Smith.

Micrasterias sol var. *ornata* Nordstedt. (Pl. I, Fig. 10.)

Abundant in several localities: Riverview, Childs, Okeechobee, etc. Specimens with zygospores were found at Riverview in April, 1933.

Zygospore spherical with stout acute spines, some of which are curved. Diameter of zygospore without spines, 83–86μ. Length of spines, 38–45μ; thickness at base, 9μ. Length of cell, 196–214μ; breadth of cell, 200–203μ; breadth of isthmus, 21–22μ.

Staurastrum muticum var. *minor* Wolle. (Pl. I, Fig. 6.)

The zygospore of *Staurastrum muticum* shown in W. & G. S. West (Vol. 4, Pl. 118, Fif. 20) (from Ralfs) does not agree with those found

near Kissimmee. Cushman (1903, p. 224) gives a description of zygospores which agree very well with those found in Florida. Either Ralfs has incorrectly figured the zygospore of this species, or else the smaller form has zygospores quite different from the species vera, in which case it would be entitled to specific rank. Further data are needed before a correct assignment can be made.

Mateola n. gen.

Cells united into twisting filamentous colonies. (No gelatinous sheath evident). Body of cell about twice as long as broad, shape of a right parallelopiped with each of the eight corners extended into a thick process, making complete outline of cell roughly cubical. Processes semicrescent-shaped with cusps diverging from isthmus. A chloroplast in each semicell having two pyrenoids.

Zygospore unknown. Figure shows cells in process of ordinary cell division.

Mateola acutiloba n. sp. (Pl. I, Fig. 9.)

Description as in genus.

Length of cells, 30μ; breadth over all, 41μ; breadth of apices, 13μ; breadth of isthmus, 22μ.

Habitat: Pond between Sanford and Mt. Dora, Fla. Collected December, 1932.

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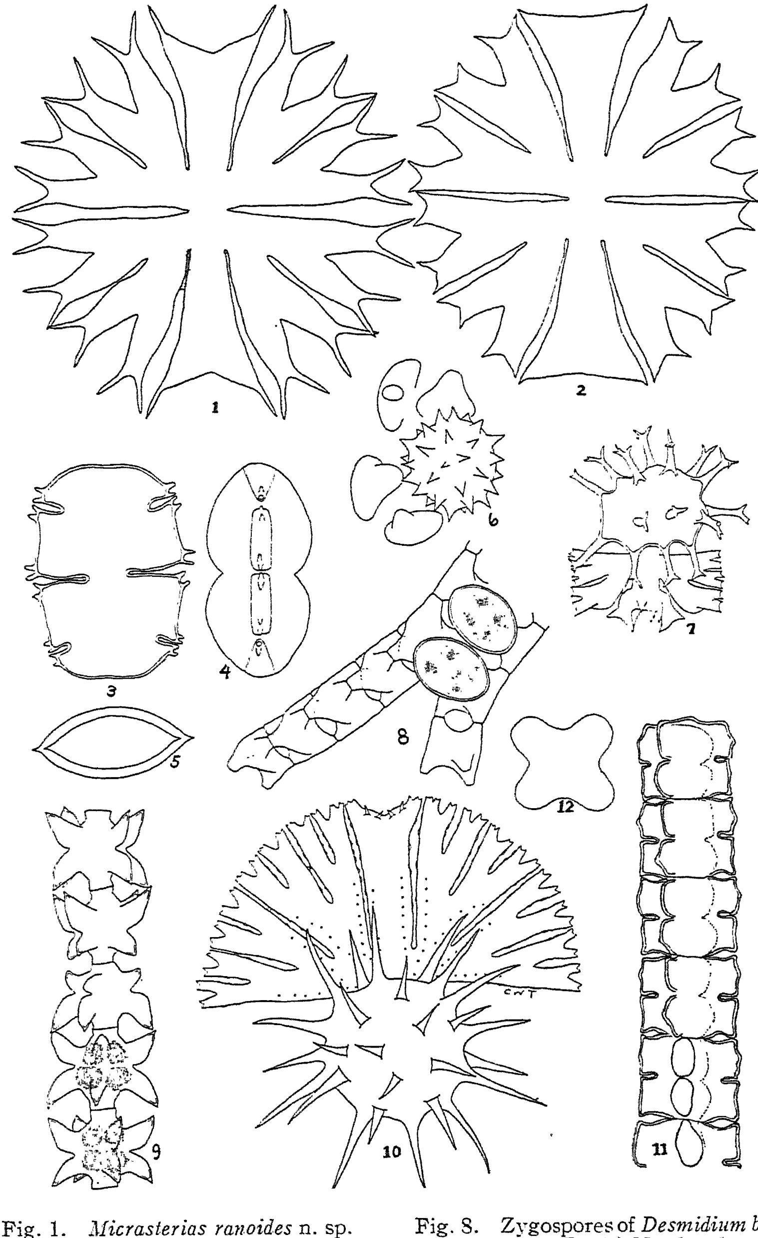

Fig. 1. *Micrasterias ranoides* n. sp.
Fig. 2. *Micrasterias floridensis* n. sp.
Figs. 3-5. *Micrasterias piquata* n. sp.
Fig. 6. Zygospore of *Staurastrum muticum* var. *minor* Wolle.
Fig. 7. Zygospore of *Micrasterias foliacea* Bailey.
Fig. 8. Zygospores of *Desmidium baileyi* (Ralfs) Nordstedt.
Fig. 9. *Mateola acutiloba* n. gen. et sp.
Fig. 10. Zygospore of *Micrasterias sol* var. *ornata* Nordstedt.
Figs. 11-12. *Phymatodocis nordstedtiana* Wolle.

BOOK NOTICES

Beetles

This publication should be of invaluable assistance to research workers in entomology, especially those who are interested primarily in Coleoptera. The subject matter accumulated by the compiler contains citations to technical descriptions in literature of the egg, larva, and pupa of the Coleoptera of America North of Mexico. This paper supplements and brings down to date the work published by Wm. Beutenmuller in 1891, entitled "Bibliographic Catalogue of the Described Transformations of the North American Coleoptera" in the Journal of the New York Microscopical Society, Vol. 7, pages 1–52. The arrangement of the material is somewhat in conformity to the general plan followed by Henry Edwards in his "Bibliographical Catalogue of the Described Transformations of North American Lepidoptera," published in 1889 as U. S. National Museum Bulletin 35. Each reference includes the following information: name of genus; name of species, if known; name of author of original description of adult insect; notation of the various stages of which description is cited, as egg, larva, or pupa, and whether or not illustrations are included; biological data; name of author of additional descriptive material; periodical or other work in which description appears, with volume, page, and date. All references are arranged alphabetically, first by genera and then under each genus, alphabetically by species.—R. DAVIDSON.

A Contribution to a Bibliography of the Described Immature Stages of North American Coleoptera, by J. S. Wade. Mimeograph Number E-358 of the U. S. Dept. of Agriculture, Bureau of Entomology and Plant Quarantine, Washington, D. C., September, 1935.

Insect Enemies of Shade Trees

The author, in writing this book, brings together considerable information concerning insect injury to shade trees. There has been an increasing demand for such information, especially in recent years because of increased interest in forestry problems.

There are three introductory chapters: The Value of Shade-Trees and General Methods of Protection from Insect Attack; Materials and Apparatus for the Control of Tree and Shrub Insects; Suggestions for the Treatment of Weakened Trees. Following these a chapter is devoted to each of the important shade trees and shrubs giving the various insects which attack them, means of detecting their presence, their life histories, nature of attack, and the best means of control. An index to the trees and shrubs is given in addition to the general index. This cross-referencing increases the utility of the book. Many references to literature are given following the discussion of a particular insect problem. The book is well written and well illustrated on good quality paper.

It should serve not only as an excellent reference for members of State Departments of Agriculture, home owners, and Extension Entomologists, but for students of forestry and forest entomologists as well.—R. H. DAVIDSON.

Insect Enemies of Shade Trees, by Glenn W. Herrick. 417 pp. Ithaca, The Comstock Publishing Company. 1935.

Earth

For those who want a light and interesting but withal accurate tale of the earth, this new book by J. H. Bradley will be found suitable. Bradley has taken the story told by the earth and rewritten it in a manner which is easily understood. The entire history is dramatized, and as the picture is unfolded we find a delightful story dug out of the rocks and presented to us in charming and living style. It is very good reading, and well worth the time spent. The 8 illustrations are more or less modernistic.—WILLARD BERRY.

Autobiography of Earth, by John Hodgson Bradley. 348 pp. New York, Coward-McCann Inc. 1935.

Sound

This little book is an expansion of the author's presidential address before the Acoustical Society of America in 1932. It presents in an interesting style the contributions of important persons in this field from Pythagoras to the beginning of the 20th century. Short personal sketches of the pioneering efforts of outstanding contributors to acoustical problems are grouped under such headings as: harmonics and acoustics, early experimentation, music, the era of the calculus, the science of sound, theories of sound, etc. There are numerous illustrations of important personages, early apparatus, etc. It will prove interesting particularly to students beginning the study of acoustical problems, although as the title indicates it is by no means an intended or achieved comprehensive history of this field.—S. RENSHAW.

Anecdotal History of the Science of Sound, by D. C. Miller. xii+114 pp. New York, the Macmillan Co., 1935.

Science of Man by a Man of Science

The distinguished Nobel Prize Winner Alexis Carrel has turned his hand to a treatise on man, and the result is disappointing. The book is frankly teleological, metaphysical and metapsychical. It is crammed with facts and near-facts, but they are inextricably entangled with the author's personal opinions, which are, to say the least, unorthodox. An occasional plain mistatement of fact occurs, such as on page 90 and again on page 250, where the ovum in its development is said to eject half of each chromosome in the reduction division.

The author exhibits a sincere belief in clairvoyance, mysticism, telepathy, and the power of prayer over disease: strange beliefs indeed in a scientist; beliefs, however, which he hopes will not be merely laughed off, but investigated with the techniques of physics, physiology and medicine.

A chapter on adaptation uses almost entirely teleological explanations. The best chapter in the book concerns physiological time. There are several good discussions of the interactions of heredity and environment. Here and there one meets with surprisingly good eugenic suggestions.

The climax of the volume is reached in the final chapter on the remaking of man. The suggestions are unique, a strange mixture of clear insight and impractical subjective idealism. If the scientific reader can control his exasperation long enough to finish the volume, he will find the reading worth while if for no other reason than the controversial issues it raises. The lay reader, unfortunately, will find in the book justification and backing for many of his superstitions and dogmas.—L. H. S.

Man, the Unknown, by Alexis Carrel. xv+346 pp. New York, Harper and Brothers, 1935.

Genetics and Society

This little volume is a concise straightforward presentation of the facts, principles and legitimate inferences of genetics, leading to a discussion of eugenics. The author knows his genetics thoroughly, and expounds it well. He thinks clearly, and expects the reader to do likewise. For the eugenecist the author has nothing but pity. He feels that eugenics as now concieved is not only useless, but socially dangerous. The eugenecists, he claims, demand, with unabashed impudence, sterilization for the sole purpose of saving humanity from the misery of disease, deformities and incompetence, and yet find nothing but approval for an economic system which brings misery to the vast majority of mankind. The author pleads for a better social environment, which if attained, will not only be valuable for its own sake, but should make it possible to accurately determine the role of heredity in the production of human traits; an accuracy which is at present woefully lacking. He likewise contends that so long as an individual performs a socially useful task, he is on a par with any other member of society doing socially useful work. The genetics of the book is splendid; the eugenics is subject to some debate. The book should most certainly be critically read, however, by all biologists.—L. H. S.

Genetics and the Social Order, by Mark Graubard. 127 pp. New York, Tomorrow, Publishers, 1935.

Endocrines

Pioneering in the graphic presentation of informative material Miss Gregory has prepared this interesting and effective book dealing with the endocrines. The graphic methods of expressing a fact or conveying an idea should popularize the work and make it of interest to the general reader without any great sacrifice of scientific accuracy. The retention of scientific accuracy makes the work of value to the student and medical practitioner. The originality of this book lies in the method of presentation rather than subject matter. Each endocrine gland is taken up separately and its story told by a series of charts and diagrams. The last chapter presents information on glandular relationships in the same manner. A useful glossary is included.—T. S. SUTTON.

A B C of the Endocrines, by Jennie Gregory, 126 pp. Baltimore, The Williams and Wilkins Company, 1935.

Marching Deserts

During the last year dust has been blown into regions where no foreign dust had fallen in the memory of man. The newspapers told us of the great dust storms of the grain belt. Much was said of the storms, but little of the cause and still less of the cure. It remained for Professor Sears to give us the cause and effect and to discuss the means of a cure. In his "Deserts on the March" he traces the slow depletion of the soil and the lack of logical conservation of fertility of the land, due partly to lack of knowledge and partly to the careless habits of society. The effects are loss of pasture, loss of forest (and lumber) and finally loss of the productive soil, thus killing plants and animals both on land and in inland waters, besides causing floods and dust storms. What effect will this destruction have on our future population who will need food and water even as you and I? The cure is careful long range regional planning which will direct the users of the soil into the proper management of the land. It cannot be accomplished over night but, if we as a nation are to prevent the rape of the soil, we must allow and support intelligent investigations into uses of the land.

Professor Sears has presented marching deserts with the delightful fascination of a novelist. We hope this strongly written book will bring home the facts of the case to the persons concerned and help in showing all of us how to correct this growing loss.—WILLARD BERRY.

Deserts on the March, by Paul B. Sears, 231 pages. Norman, Oklahoma, The University of Oklahoma Press, 1935.

Fossil Invertebrates

The authors recognize 12 phyla of invertebrates. In checking over this dozen a paleontologist will miss our old friends "Vermes" which are here handled from the modern zoological classification, including Platyhelminthes, Nemathelminthes, Trochelminthes, and Annelida. This is a logical move as it makes comparison of living forms much clearer. Another missing friend is Molluscoidea which is here divided into separate and distinct phyla; Bryozoa and Brachiopoda. This is not a new separation but it is pleasing to see that the authors have not fallen back on the older classification. The other phyla are stereotyped. In discussing the various phyla they are usually divided to the rank of orders and occasionally lower. The classes are the main units of discussion and the ecology and geologic history of each class are generally given; in some cases larger groupings are considered together. References are grouped at the end of the phylum discussions. The illustrations are both linecuts (some diagrammatic) and halftones, well selected and many from quite recent publications. There are 175 "figures" some having as many as 27 illustrations per figure. There are also 11 charts showing geologic range of various groups. There is quite a complete index.

This new invertebrate paleontology is more detailed than any modern invertebrate texts in English. The discarding of "Vermes" and the use of the modern classification is excellent. For beginning students in invertebrate paleontology it should prove very useful. It is gotten up in the usual excellent style of the publishers.—WILLARD BERRY.

Invertebrate Paleontology, by W. H. Twenhofel and R. R. Shrock. xvi+511 pp. New York, McGraw-Hill Book Company, 1935.

Geology for Engineers

This book is divided into 3 parts. Part I is on building material, in which certain theoretical considerations are discussed, including the common rock-forming minerals, the principle rock types, their occurrence and physical character, and some 28 pages devoted to the choice of materials. Part II is on Field Operations. Here the earth's crust and earthquakes are discussed, followed by a treatment of landslides, quarrying, tunnelling, retaining walls both above and below ground and building sites. Part III takes up water supplies, including discussed rainfall, rivers, tides, surface and subsurface water, and the quality of water. The author uses many actual examples to bring out his ideas. The examples are usually well illustrated, either with diagrams or photographs. For instance, some 25 photomicrographs are used in Part I in the discussion of building materials. As would be expected the illustrations are largely drawn from the author's field experience, whicih is India.

There are a rather large number of what are evidently typographical errors which detract greatly from the book. On page 7 ultra-violet light is given as $4x10^{-5}x10^{-7}$ whereas it should be $4x10^{-5}$ to $4x10^{-7}$. On page 38 a table on chemical composition (of rocks) referred to Clarke's Data of Geo-Chemistry Bulletin 330, U. S. Geological Survey, p. 261, is found on page 31 of the Bulletin which was published in 1908. This bulletin has been revised 5 times since then, the latest being published as U. S. Geological Survey Bulletin 770 in 1924. The table in the later editions has been brought up to date as information has become available. The body of the table does not check with Clarke's table. In igneous rocks Clarke has Cl 0.07%; Fox gives 0.42%. In shales Clarke has alumina 15.40%; Fox gives 15.04%. Chlorine Clarke has as 0.00; Fox gives 1.49. In sandstones Clarke records no chlorine; Fox gives 0.12%. In limestone Clarke records chlorine 0.02%; Fox gives 0.12%.

On page 90 the refractive index of Canada balsam is given as 1,534 (should have decimal point not comma); in the following table the figure is 1.54, in same table on page 91 as 1.534, and on page 92 as 1.543. The usual index used for Canada balsam is 1.54.

Page 111 says " . . most of which (20 percent) is in the form of silica, 25 percent of alumina . . "; certainly 20% is not most, especially as 25% is definitely stated to be alumina. But why go on? The examples are numerous. In addition, the references are often incomplete, as for example, "The most recent of these ('Economic Aspects of Geology' by C. K. Leith) gives . . ." It may be most recent (being published in 1921), but no date of publication being given makes it difficult to locate the reference for one unacquainted with the literature (and the book is apparently for beginners). There is no collecting of references either as footnotes or at ends of chapters, or at the end of the book itself. As a textbook it gives too little geology to be called engineering geology. For a handbook of engineering practice it might pass, but this reviewer would never give it to students. All in all, it can not be recommended as a text in engineering geology.—Willard Berry.

A Comprehensive Treatise on Engineering Geology, by Cyril S. Fox. 392 pages. New York, D. Van Nostrand Company, 1935.

Why and How?

It is a familiar phenomenon to research workers that the solving of one problem only serves to open up more and varied problems. In this volume the author undertakes to show how many unsolved problems there are in science, in spite of the rapid advance of knowledge in recent decades. Such problems range from the creation and the nature of the universe, to the origin of life and the nature of physiological processes. Some of these are inherently insoluble, others are subject to slow progress, and still others may be considered as approaching solution. For most of them, however, the scientist may well be content to discover what appears to be the basic economy of the natural world, and to learn, so to speak, how to oil the works when he can get at them. In an age in which rapid scientific advancement is taken for granted, such a book as this may well cause us to pause and consider some of the unsolved problems.—L. H. S.

Unsolved Problems of Science, by A. W. Haslett. xi+317 pp. New York, the Macmillan Co., 1935.

Structural Geology

Some time ago Bohuslav Stoces published a book in Czech and German on structural geology which was widely acclaimed. It remained for Charles H. White to elaborate the work of Stoces and publish it in English. This textbook of applied geology is divided into 2 main parts: primary structures of rocks, and induced or secondary structures due to orogenic movements in the earth's crust. The primary structures are discussed throughout 108 pages, in which are taken up structures of sedimentary and igneous rocks and associated mineral deposits. In the second part after a brief discussion of causes and results of movement, there are taken up folding, faulting, joints, veins, unconformities and associated surfaces, types of structures in folded and faulted regions, relation of folding to ignious activity and mineralization. The last 58 pages concern surveying and mapping structures, geophysical methods, geologic maps and influence of structures on mining practice. There is a short glossary and bibliography.

The authors make no attempt to explain exactly why and how the various structures originate. They try to tell what the structure is and how to recognize it. For yhis purpose descriptions and excellent illustrations, both diagrams and photographs, are used. (There are 664 illustrations in 460 pages.) The illustrations are largely European and a welcome relief to those accustomed to certain, much used illustrations of English structural geologies, being so very well illustrated. Because of elaboration and additions, especially of illustrations, it is an advance over Stoces' original Czech and German text on the same subject. As a textbook for geologic structures and as a dictionary of structures for the geologist it can be well recommended.—WILLARD BERRY.

Structural Geology, by Bohuslav Stoces and Charles Henry White. 460 pages. New York, D. Van Nostrand Co., Inc., 1935.

Predaceous Coleoptera

In the entomological literature throughout the world many valuable papers and notes occur which present data on the natural enemies of insects. Compilations of such information are of decided value to investigators interested in biological control. One of the first compilations on this subject matter in the english language has been assembled and published by Dr. Balduf in his excellent new book entitled "The Bionomics of Entomophagous Coleoptera."

The book presents in fairly complete form all the important and known biological information on fifteen or more families of predacious beetles. For each family data on the following topics and others are presented, namely; general features, habitats, activities of the adults, natural enemies, food and feeding of the adults, mating, oviposition, incubation, hatching, activities of the larvae, locomotion, respiration, food and feeding of the larvae, economic importance, hibernation, aestivation, pupation and life cycle. Over one hundred figures of insects and their parts are inserted in the text. Those redrawn by Mrs. Balduf are clear cut and nicely drawn. The literature cited is presented at the end of the book under each family of Coleoptera. The author also has prepared a fairly complete index of authors, insects and other facts. The book is planographed, 8 x 11 inches, and bound in cloth.

This reviewer has had considerable experience in compiling information of this character, consequently he appreciates the great amount of tedious work and painstaking efforts needed to compile a book such as Dr. Balduf has produced. It is hoped that this author or others will continue to assemble the widely scattered information on other groups of entomophagous or parasitoid insects.—ALVAH PETERSON.

The Bionomics of Entomophagous Coleoptera, by W. V. Balduf. 220 pp. Published and planographed by John S. Swift Co. Inc., St. Louis, Mo., 1935.

The Study of Psychology

This is the tenth book in the Prentice-Hall Psychology Series, edited by F. A. Moss. The Study Outline follows no single textbook of general psychology but is intended for use with any one of thirty-five of the texts in most common use. Each of the thirteen chapters follows the same pattern: first, a summary of the content, then exercises and review questions, and finally a bibliography

with references to specific chapters in the textbooks of general psychology as well as to large numbers of books and articles pertinent to the subject discussed. The summaries are usually sound and to the point, the exercises and review questions provocative of thought, and the bibliographies show that the available sources have been well canvassed. With the exception of the field of motivation which is treated with too great brevity, The Study Outline covers the field of the introductory course very ably.

Physically the book is large, nine by fourteen inches, paper bound, and has wide margins for notes. All the leaves are perforated, thus allowing those used for assigned exercises to be torn out and handed in.—R. C. CHALLMAN.

Study Outline for General Psychology, by S. L. Crawley. ix+223 pp. New York, Prentice-Hall, Inc., 1935.

Eclipses of the Sun

The very earliest records of history have brought to us accounts of solar eclipses and indeed probably no other natural event has ever made such an impression on the human consciousness from the early primitive to the modern sophisticate. It is distressing, therefore, to find that this fourth edition of what might be the standard work in the field, continues to be a combination of travelog, popular-scientific and scientific record. There is much in the book that is good, entirely too much that is superfluous, omitted, or poorly balanced in relation to other subjects. The author has inadequately discussed the early history of eclipses: a pity, because of their importance in the establishment of early dates. There follows chapters on prediction and verification of eclipses, then two chapters on the history of the spectroscope which undoubtedly make interesting reading for the lay reader, but for which there is small place in a book of this title. After a few general remarks concerning the sun, there begins the travelog leading up through the author's personal experiences on a number of eclipse expeditions.

One of the outstanding faults of the book occurs in a twenty-page discussion on the structure of the atom. The reviewer is frankly astonished that any modern author of a book on physical science should devote space and emphasis to the Bohr circular orbit theory of the hydrogen atom when this theory has been quite obsolete for at least ten years, receiving mention nowadays only as an example of how an atomic theory ought not to be.

In brief then, the book leaves much to be desired as a contribution to scientific literature. This will not, however, prevent its being an interesting narrative to an uncritical lay reader who wants to learn something about the sun and its eclipses.—C. E. HESTHAL.

Eclipses of the Sun, by S. A. Mitchell. Fourth edition, revised and enlarged. xvii+520 pp. New York, the Columbia University Press, 1935.

The Invertebrates Revised

The first edition of this standard work was noticed in this journal (Vol. 32, p. 435). The revised edition is 80 pages longer, with much new material on physiology, and more complete general discussions. The newly-added discussion of organism and environment, and the excellent revised summary of the comparative physiology and morphology of the metazoa may be mentioned. The chapter on the Insecta has been considerably enlarged, with additions on insect physiology and more detailed descriptions of the various orders. Minor changes and additions have been made in the classification, and a number of new figures added. Revision has produced a more complete and coherent textbook, with greater emphasis on life processes. It remains the most concise and well-written recent book in its field. As in the preceding edition, some of the descriptions of type forms seem insufficiently detailed, and the discussion of evolution and phylogeny is woefully limited.—HERMAN VON DACH.

The Invertebrata: A Manual for the Use of Students, by L. A. Borradaile and F. A. Potts, with chapters by L. E. S. Eastham and J. T. Saunders. Second edition. xv+725 pp., 483 figs. New York, The Macmillan Co. (Cambridge, at the University Press), 1935.

The Story of Multiple Stars

At least one star in every eighteen seen in the northern hemisphere through the 36-inch telescope of the Lick Observatory is a multiple system of two or more stars. A statistical study makes it seem very probable that about two-fifths of all the stars are multiple. From this the importance of the subject soberly and adequately discussed in this book can readily be inferred. The author, director and astronomer emeritus of the Lick Observatory of the University of California, is one of the leading contributors to this field of astronomy. He has achieved a well considered balance between the amount of space devoted to the historical development of the subject, exposition of the experimental and mathematical methods, and the discussion of the results so obtained.

The last four chapters in the book are devoted to a summary and interpretation of the known facts. A few of the most interesting systems are described in detail. The possible theories of origin of multiple stars are critically examined. The conclusion to which the author comes is that there is, as yet, no satisfactory theory. Although several thousand systems have been examined, the amount of data so far obtained is insufficient to provide a suitable foundation for an adequate theory.

The book is primarily intended for readers who have some training in astronomy and mathematics, but 140 of the 280 pages of text could be read by anyone with no other preparation than an interest in astronomy.—C. E. HESTHAL.

The Binary Stars, by Robert Grant Aitken. Second edition, revised. xii+309 pp. New York, McGraw-Hill Book Company, 1935.

What of the Future?

A visit to the Century of Progress Exposition impressed Dr. Furnas with the fact that while much seeming progress was shown, much of the progress and efficiency which one might reasonably expect was sadly lacking. So impressed was he by thoughts of this kind that he conceived the idea of a book on what our "Century of Progress" had failed to produce or to solve. The result is a very fine discussion of our unsolved problems. Beginning with biology, which he considers as less fundamentally important than physics or chemistry, but first in the public mind, the author continues through chemistry, physics, engineering and finally the social sciences. Dr. Furnas displays a profound knowledge of all of these subjects. He discusses them with clear insight, forceful logic, and delightful literary style. A fine sense of humor permeates the book, and breaks out irrepressibly at frequent intervals. This is one of the "must" books of the year.

—L. H. S.

The Next Hundred Years, by C. C. Furnas. xiv+434 pp. Baltimore, the Williams and Wilkins Co., 1936. $3.00.

Another Astronomy for the Layman

Stimulated by the success of two prominent English authors who have written popular books on astronomy and physics, several authors have turned their attention in the same direction. One of these, the Astronomer Royal of England, is the author of this book. To the interested but uninformed reader, it will undoubtedly be worth the reading time. As a second book following one of those above referred to it will be a disappointment because the reader will already have been supplied with something better, though more difficult.

The book is written in a very simple, understandable style and should be popular with readers of Junior College age. There is a commendable chapter dealing with the question of life on other planets in which the author discusses the physical evidence for living conditions, discarding all planets, as do most authors, except Venus and Mars. Limitation of the discussion to the physical evidence is unfortunate. The biological factors should be given equal weight with the physical but perhaps this is too much to expect of an astronomer author. The book is liberally illustrated with the usual selections.—C. E. HESTHAL.

Worlds Without End, by H. Spencer Jones. xv+329 pp. New York, The Macmillan Co., 1935.

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EARLY DEVELOPMENTAL STAGES OF THE HUMAN LUNG

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INTRODUCTION

The lung appears to be the last of the large organs of the human body about which a complete unquestioned embryological story has been built. In fact, the origin of the lung may be said to be as yet rather obscure.

In the latter part of the last century the theory was clearly expounded by Kölliker (1), Aeby (2) and His (3) that the entire lower respiratory passage (from larynx outward to and including the alveoli) arises as a diverticulum of the foregut.

This idea has led to much investigation in recent years and some doubt has been expressed as to its accuracy. From various observations a second theory has been developed which states that the lung may have a dual origin, such as has been shown to be the case in the kidney (Rose (4), Policard (5), Terni (6)). It has been postulated that the larynx, trachea, bronchi, bronchioles, and the part of the respiratory bronchioles lined with cuboidal epithelium arise from the foregut diverticulum while the remainder of the respiratory bronchioles, the alveolar ducts, alveolar sacs and alveoli arise from the mesenchyme into which the diverticulum branches. Assuming this theory to be true, the mode of union of these two embryonic components to form the completed tracheo-bronchial tree has never been demonstrated.

His (3), Narath (7), Merkel (8) and Blisnianskaja (9) carefully described the lungs in the human embryo but their accounts did not trace the development very far into the period of the foetus (third to ninth months inclusive). Thus there seems to be a need for more descriptions of developmental stages of the human lung. These studies are being made with

the idea that the nature of the tracheo-bronchial tree may be elucidated by tracing its development in a series of human embryos and foetuses. The lungs described in this paper complete the study to the 118 mm. C. R. stage. The first five specimens have been selected to form a well-spaced series as to crown-rump length. The original idea of continuing this rather close-spaced series was dropped because it appears that the description of lungs in the third month of prenatal development (foetuses from about 25 to about 75 mm. C. R. length) would only be a recitation of the continued growth of the epithelial anlage described in the first and second months of prenatal development. For a stage in the fourth month, a specimen was selected that shows excellent tissue fixation and that has a complete history. The menstrual age of this foetus was 109 days and the C. R. length is 118 mm.

In a recent paper the author (12) has rather fully described the human foetal lung at the 152 mm. stage (in the fifth month). The heart of this foetus beat for some minutes after delivery but there were no respiratory movements. The tracheo-bronchial tree at this stage has a continuous intact lining of epithelium and the maximum number of generations of tubules forming the tree is seventeen. The lining of the terminal tubules was a light-staining cuboidal epithelium, enclosing a small lumen.

The author is satisfied that a description of further stages in the gaps between 35 and 118 mm. C. R. length and between 118 and 152 mm. C. R. length would not add any essential facts to the story, and feels warranted in drawing the conclusion that the human tracheo-bronchial tree as found in the 152 mm. C. R. stage is entirely a product of the foregut entoderm. If there is a contribution from the mesenchyme to the human tracheo-bronchial tree it does not occur before the 152 mm. stage.

MATERIAL AND METHODS

The embryos that are described in this paper were selected from a large group on the basis of gross and microscopic appearance. The specimens were carefully measured in the crown-rump (C. R.) axis before sectioning. These measurements were:

Embryo I	11 mm.
Embryo II	15 mm.
Embryo III	19 mm.

Embryo IV	23 mm.
Embryo V	35 mm.
Embryo VI	118 mm.

The specimens were fixed in formalin, imbedded, sectioned, mounted serially and stained routinely.

Wax reconstructions of the gross lung, of the complete tracheo-bronchial tree in Embryos II and IV, and of portions of the tree in the other specimens were prepared by projecting the sections on wax plates of the appropriate thickness. An Edinger projection apparatus was used.

A. MORPHOLOGY OF THE GROSS LUNG

LENGTH OF THE LUNGS: These measurements were taken either from the apex (superior pole) to the inferior pole as in Embryos I-IV, or from the apex to the posterior margin of the base as in Embryos V and VI.

	Right Lung	Left Lung
Embryo I	0.70 mm.	0.60 mm.
Embryo II	1.43	1.20
Embryo III	1.80	1.70
Embryo IV	2.08	1.80
Embryo V	5.08	5.24
Embryo VI	14.20	15.10

RIGHT LUNG (Plate I)

At the 11 mm. stage the right lung is an elongated loaf-shaped mass, flattened dorso-ventrad. At the 15 mm. stage the superior portion of this mass is the more bulky; the whole lung is the shape of an inverted pear. During the period from the 15 to the 35 mm. stages a sloping basal surface develops to replace the pointed inferior pole. As a result the shape of the right lung, while still piriform, is reversed, since the base of the pear is now downward. The sterno-costal surface of the right lung presents elevations at both the 11 and 15 mm. stages. During the 15 to 19 to 23 mm. intervals these elevations disappear over the superior and middle lobes, but traces of them are still present on the inferior lobe at the 35 mm. stage. By the time of the 118 mm. stage the right lung has the adult form, with entirely smooth surfaces.

LOBES AND FISSURES

1. *Superior Lobe.*—The anlage of the superior lobe at the 11 mm. stage is an ovoid lobule which faces dorsolaterad and which is incompletely separated from the anlage of the middle lobe. The groove partially separating these two lobes begins dorsad at the anlage of the oblique fissure and as the two lobes grow, extends ventrad. The superior lobe forms but little of the anterior border of the lung until the 19 mm. stage. From this latter stage to the 35 mm. stage, the superior lobe grows to a more anterior position. In effect, the superior lobe is rotated ventrad along the circumference of the inside of the thoracic wall during the 19–35 mm. interval, by the development of the inferior

lobe below and behind it. Meanwhile the superior lobe itself is growing and expanding laterad (Plate I). It appears that the superior lobe which arises from a more orally located portion of the right primary bronchus than do the middle and inferior lobes, is more mature than these latter lobes. The superior lobe at first grows dorso-laterad, then laterad and finally antero-laterad.

2. *Middle Lobe.*—The anlage of this lobe at 11 mm. is an incomplete lobule that faces directly laterad. By the time of the 15 mm. stage the lobule has grown ventrad to help form the anterior border of the lung. In the succeeding stages the middle lobe becomes relatively more inferior in position as the superior lobe develops above it, and more anterior in position as the inferior lobe develops below it. At the 35 mm. stage the superior lobe overhangs the middle lobe, but by the 118 mm. stage the middle lobe has become relatively larger in outline and more bulky, establishing the adult form. Thus it appears that the middle lobe grows at first directly laterad, then is carried downward by the growth of the superior lobe and rotated forward by the increasing mass of the inferior lobe. Finally, the middle lobe comes to lie in the angle between these two lobes. The adult position is inferior (in addition to anterior) because the superior lobe is more mature and bulky at each developmental stage than the middle lobe (Plate I).

3. *Inferior Lobe.*—At the 11 mm. stage the inferior portion of the loaf-shaped right lung represents the anlage of the inferior lobe. It is incompletely separated from and partly surrounds the middle lobe but is more completely marked off from the superior lobe. There are four elevations on the anlage of the inferior lobe, namely: one superior and dorsal, one superior and ventral, a third inferior and lateral and the fourth forming the inferior pole. At the 15 mm. stage the inferior lobe is more elongated and lies entirely inferior to the superior and middle lobes. The inferior pole has become more pointed. By the time of the 19 mm. stage the lower pole is being replaced by a surface. The posterior margin of this new surface is still sharply pointed. At the 23 mm. stage a sloping basal surface is present, and the lobe as a whole is pyramidal in shape with the apex at the superior end. The sterno-costal surface still presents elevations. These elevations are indistinct at the 35 mm. stage, and by the time of the 118 mm. stage the lobe with all surfaces smooth is a miniature of the adult inferior lobe.

4. *Oblique Fissure.*—At 11 mm. this fissure is represented by an incomplete and shallow groove. The anterior portion of this groove lies almost horizontal. By the 15 mm. stage this groove is much deeper, extends downward and forward, and makes a 30 degree angle with the horizontal. At the 15 and 19 mm. stages the oblique fissure is deepest at the point of junction with the transverse fissure. At the 23 mm. stage the oblique fissure makes a 45 degree angle with the horizontal due to the fact that the superior and middle lobes are farther developed than the inferior lobe at this stage. By the 35 mm. stage the oblique fissure is complete.

5. *Transverse Fissure.*—At 11 mm. the transverse fissure appears as a short groove extending from the anlage of the oblique fissure a

short distance ventrad and slightly upward. The fissure is complete at 15 mm. and at both this stage and at 19 mm. is deep in its posterior portion and shallow toward the front. By the time of the 23 mm. stage the *transverse* fissure is almost in that position, due to the rapidly increasing bulk of the superior lobe. This latter fact also accounts for the finding that the plane of the transverse fissure at the 35 mm. stage is directed upward as well as mesiad from the surface. In other words, the superior lobe overhangs the middle lobe. By the 118 mm. stage adult relationship has been developed.

LEFT LUNG (Plate II)

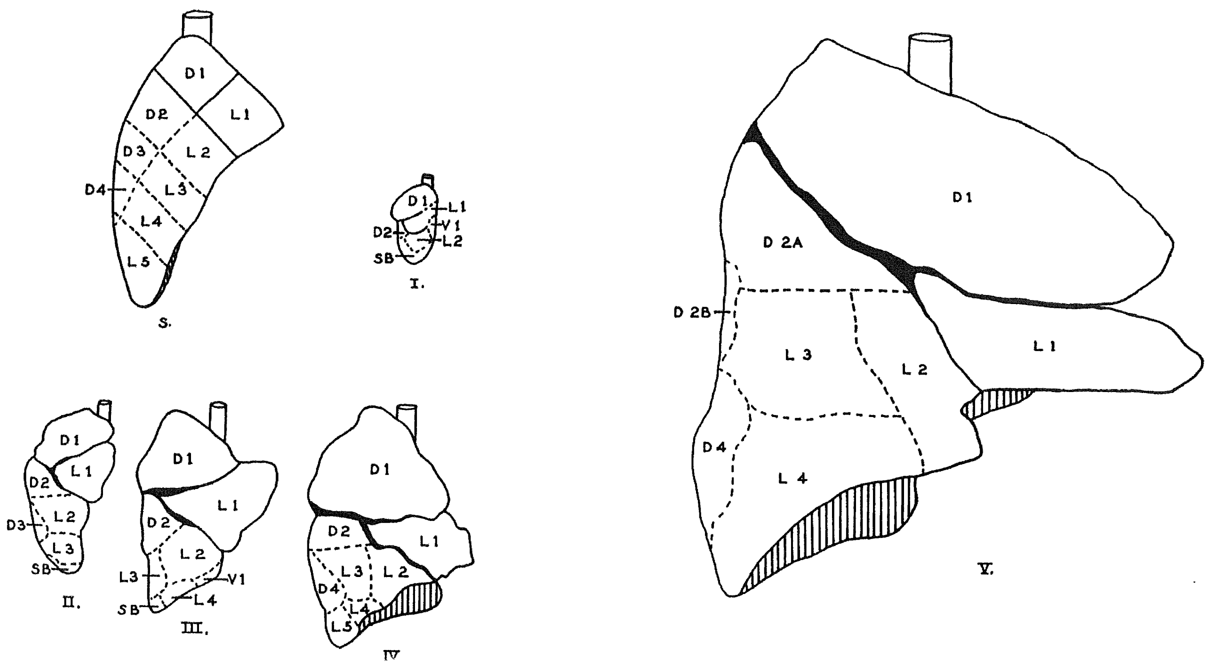
During the first two months of prenatal life the left lung is less elongated than the right, but early in the third month the situation is reversed, the left lung becoming and remaining the longer. In contrast to the six elevations on the right lung anlage at the 11 mm. stage, only five elevations are seen on the left lung. At each stage of the growth period under study, the superior lobe appears more mature than does the inferior lobe.

LOBES AND FISSURES

1. *Superior Lobe.*—The anlage of the superior lobe at the 11 mm. stage is an ovoid mass consisting of two conjoined lobules, a larger dorsal and a smaller ventral. These lobules are demarcated by a faint sulcus which is still present at the 19 mm. stage. At the latter stage the two lobules are of about equal size. At the 23 mm. stage the lobules are no longer distinct and the area corresponding to the ventral lobule is again smaller than the dorsal area. The groove between these two areas is very shallow at both the 23 and 35 mm. stages. At the latter stage a cardiac notch is present on the anterior border. At this stage this border and its notch lie directly lateral to the heart rather than anterior to it. At the 118 mm. stage the left superior lobe is a miniature of the adult specimen, with the exception of an incomplete fissure extending backward from the anterior border. This fissure begins just above the cardiac notch and extends backwards for 6 mm. but does not meet the oblique fissure. This additional fissure is to be regarded as an abnormality and not as a structure peculiar to the left superior lobe at the 118 mm. stage.

2. *Inferior Lobe.*—At the 11 mm. stage the anlage of the inferior lobe is an ovoid mass presenting three elevations, namely: a dorsal, a ventro-lateral and one formed by the lower pole. The depressions between these elevations are less distinct than those on the right inferior lobe at this stage. During the 11 to 19 mm. interval these elevations remain and enlarge, the entire inferior lobe becoming more bulky and less pointed at the inferior pole. At the 19 mm. stage there is only a slight indication of a basal surface. At 23 mm. an almost horizontal basal surface is developing. At 35 mm. the basal surface slopes farther downward in its posterior portion and the depressions and elevations on the sterno-costal surface are but faintly indicated. At 118 mm. the inferior lobe with all surfaces smooth has the adult form.

6. RIGHT LUNGS

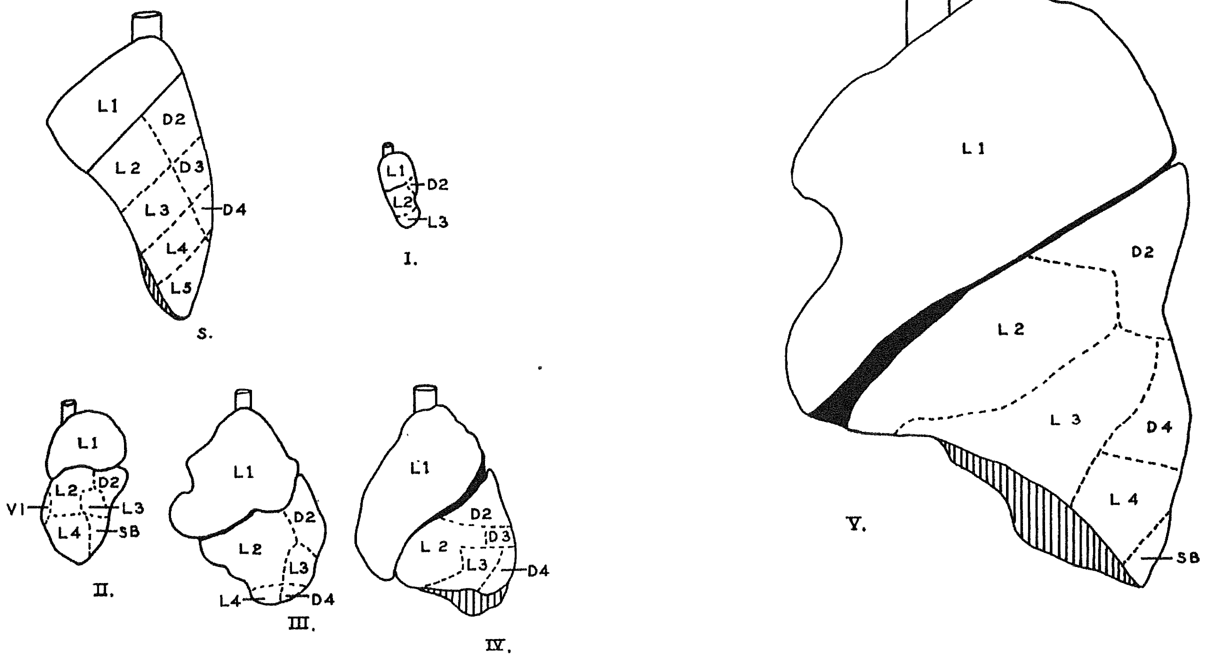


Schemata of the lateral aspects of reconstructions of the right lungs of Embryos I, II, III, IV and V, showing the areas supplied by the branch bronchi of the right stem bronchus. For comparison a schema (S) of the lobation of the lung, modified from Narath (7) is shown.

KEY: Margins and sulci—thin lines; fissures—heavy lines; plotted areas of branch bronchi distribution—dotted lines; diaphragmatic surfaces—parallel lines.

D1, D2, etc.—dorsal branch bronchi; L1, L2, etc.—lateral branch bronchi; V1—ventral branch bronchus; SB—stem bronchus.

7. LEFT LUNGS



Schemata of the lateral aspects of reconstructions of the left lungs of Embryos I, II, III, IV and V, showing the areas supplied by the branch bronchi of the left stem bronchus, compared with a schema (S) of the lobation of the lung modified from Narath (7).

KEY: Same as for Plate I.

3. *Oblique Fissure.*—At 11 mm. the anlage of the oblique fissure is almost horizontal. It is relatively deep except in its dorsal portion. At 15 mm. this fissure is complete. At 19 mm. its posterior portion is more obliquely placed. The oblique fissure is complete in respect to depth at 23 mm., and by the time of the 35 mm. stage has the adult relationships. (Plate II.)

B. TYPE AND DISTRIBUTION OF BRANCH BRONCHI

As the stem bronchi grow out into the mesenchyme and form the early lung anlagen, lateral buds known as branch bronchi arise from the walls of the stem bronchi. These buds may extend in any of the four principal directions, dorsal, lateral, ventral or medial. Those arising from the lateral aspect of the stem bronchus are the largest and most important group. These bronchi were termed "ventral" by Abey (2). They later extend more ventrad to supply the ventral portion of the lungs. However, His (3), Robinson (10) and Flint (11) term them "lateral or external" bronchi. The second most important group arise from the dorsal aspect of the stem bronchi. These are known as "dorsal" bronchi. Each dorsal bronchus (or group of dorsal bronchi in case more than one bronchus arises close together) usually arises orally to the corresponding "lateral" bronchus together with which it forms a "lung tier." The bronchi arising on the medial and ventral aspects of the stem bronchi are small and irregular. When present they are incorporated in the lung tier of that level. One exception to this statement is that one of the "ventral" bronchi found in the second "lung tier" is large. This has been called the infracardial bronchus. It usually becomes prominent in the right lung.

In the descriptions of these lungs the following nomenclature will be used: Dorsal bronchi (D1, D2, etc.); Lateral bronchi (L1, L2, etc.); Ventral bronchi (V1, V2, etc.); and Medial bronchi (M1, M2, etc.). In all cases a bronchus labelled (1) arises orad to a bronchus labelled (2) etc.

The patterns of the tracheo-bronchial trees are:

Branches of the right stem bronchus:
- Embryo I—D1, L1, D2, V1, L2.
- Embryo II—D1, L1, D2, L2, D3, L3.
- Embryo III—D1, L1, D2, V1, L2, M1, L3, L4.
- Embryo IV—D1, L1, D2, V1, L2, L3, D4, L4, L5.
- Embryo V—D1, D2a, L1, D2b, V1, L2, L3, D4, L4.

Branches of the left stem bronchus:
- Embryo I—L1, D2, L2, L3.
- Embryo II—L1, D2, V1, L2, L3, L4.
- Embryo III—L1, D2, L2, L3, M1, D4, L4.
- Embryo IV—L1, D2, L2, D3, M1, D4.
- Embryo V—L1, D2, L2, L3, D4, M1, L4.

No study was made of the tracheo-bronchial tree of Embryo VI.

A lateral view of the distribution of these branch bronchi is depicted in Plates I and II. It may be noted that the right stem bronchus of

Embryo II is the only stem bronchus that has a schematic distribution of branches; that is, it is the only stem bronchus from which the branches arise in an alterating pattern, first a dorsal branch bronchus, then a lateral branch bronchus. The other stem bronchi present a variety of patterns.

C. THE GENERATIONS OF BRONCHI

The determination of the exact number of generations of tubules present in the tracheo-bronchial tree, even in a very young embryo is a difficult problem. It is fairly well agreed that new tubules may arise by any one or by combinations of three methods, namely, lateral budding (monopodial), dichotomous branching and trichotomous branching. No definite regularity in the occurrence of these methods of tubule formation in the growing tree has been described. Furthermore, in examining an embryological specimen it should be remembered that the growth processes may have obscured the forms of earlier stages. A dichotomous branching may later appear to be a larger bronchus giving off a smaller side branch due to the more rapid growth of one of the pairs of bronchi previously formed by the dichotomous division.

In a previous paper (12) the author has described a method of estimating the number of generations present at any stage in the development of the tracheo-bronchial tree. This method requires the making of a wax reconstruction from serial sections of the lung.

In brief the method of enumeration is as follows: The primary bronchus is followed until its first branch is encountered. Then this branch bronchus is designated generation 2 and it is followed to the origin of its first branch. Now this branch is designated generation 3 and it is followed to the origin of its first branch. This is called generation 4 and the tracing is continued in this manner until the terminal blind-end tubule is reached.

Using this method the following determinations were made in the upper lobe of the right lung. The results were:

Embryo I— 11 mm	3 generations
Embryo II— 15 mm	5 generations
Embryo III— 19 mm	6 generations
Embryo IV— 23 mm	8 generations
Embryo V— 35 mm	10 generations
Embryo VI—118 mm	14 generations

In all six of these tracheo-bronchial trees it is possible to trace the epithelium as a continuous intact layer from the lining of the trachea outward to the blind end of the terminal tubule that forms the last generation.

The epithelial lining of the tree in Embryos I, II, III, and IV is of a pseudo-stratified columnar type. The lining in the first eight generations of the tree in Embryo V is also of this type. The ninth and tenth generations of this latter tree is lined in most portions by a simple cuboidal epithelium; the remaining portions are like that of the first eight generations. In Embryo V we find the appearance of cartilage plates in the walls of the first three generations of bronchi. The first

eight generations of the tree in Embryo VI are lined by pseudo-stratified columnar epithelium, while the remaining generations (ninth through the fourteenth) are lined by a simple epithelium of a cuboidal type. Cartilage plates are found in the walls of the first six generations of tubules in Embryo VI.

Throughout the extent of the tree, in all of the specimens, the line of the basement membrane of the epithelial cells is distinct. The making of wax reconstructions showed that all of the cross-sections of tubules in an area were parts of the epithelial bronchial system springing from the trachea. The branching tubules in all of these lungs lie in the relatively avascular mesenchyme, which forms the major part of the lung in these stages. There was no formation anywhere in the mesenchyme that even faintly resembled a tubule developing from the mesenchymal tissue.

SUMMARY

1. The human tracheo-bronchial tree at the 118 mm. stage has a continuous intact lining of epithelium.

2. The tracheo-bronchial tree up to and including the 118 mm. stage appears to grow entirely as a branching of the original fore-gut diverticulum; the mesenchyme has no part in its formation during this developmental period.

3. According to a method of enumeration outlined, the number of generations in the tracheo-bronchial tree at the 11 mm. stage, three, increases to fourteen at the 118 mm. stage.

4. A lobe or a portion of a lobe that has its origin more orad on the primary bronchus is more mature at any period of development than a division that has its origin farther from the bifurcation of the trachea.

5. There is considerable variation in the pattern developed in the human tracheo-bronchial tree.

I am indebted to Miss Thelma Baird, who assisted in the preparation of the serial sections. Miss Baird also prepared the illustrations.

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Applied Entomology

Since the first printing of this book in 1921 many advances have been made in our knowledge of insects and how to control them. In the field of insecticides alone there have been great advances and many of the recommended controls years ago have been modified greatly for the control of the same insect today. The author, in presenting this third edition, has included many of the more recent recommendations for the control of some of our more common insect pests. He has added discussions on the biology and control of a number of insects that have become of economic importance in recent years. The plan of presentation is the same as used in the first and second editions, i. e., that of having economic entomology organized from the systematic viewpoint rather than on the basis of host relationships. No references to literature are given. The scientific names and common names used in the book are those approved to date by the American Association of Economic Entomologists. The acceptance of these names is indeed gratifying.

The book should serve as an excellent text in a general course for beginners in entomology, and is offered at a price more reasonable than most textbooks in entomology. It is well illustrated and printed on a good quality of paper.

R. H. DAVIDSON.

Applied Entomology, by H. T. Fernald. 405 pp., 384 figs.; 3rd Edition. New York, McGraw-Hill Book Company, 1936. $3.50.

Society and its Biological Future

One of the most brilliant of American scientists has drawn upon his great store of genetic knowledge to attack the problem of man's biological future. For the present stereotyped program of eugenics he has but little sympathy. Beginning with a fine discussion of the biology of man, and of the present and potential future of society, the author presents an ultra-modern view of a truly eugenic program.

To thoroughly change the economic and social pattern of society to a truly co-operative basis; to freely disseminate knowledge of birth control; to legalize abortions as a second line of defense; to make childbirth and the rearing of children easier and less filled with drudgery; to sever love from reproduction, letting each fulfill its own separate function; to produce children, as far as possible, from the eminent men and women of the race by artificial insemination; to socialize our attitude towards our duty to future generations; to understand that the inherent differences between races are insignificant as compared with inherent differences between individuals; to unceasingly search for the ideal genetic compositions, not on the old lines of wealth and class distinctions, but along lines of "comradeliness" and intelligence, that is, highly developed social feeling and highly developed analytical ability; to reach deep into the knowledge of modern biology and shape society and the individuals composing it into an increasingly sublime creation—these are the warp and the woof of which Muller weaves his eugenic program. The book is a challenge to our modern social set-up, and to our ability and willingness to control man's destiny.—L. H. S.

Out of the Night, by H. J. Muller. x+127 pp. New York, the Vanguard Press, 1935. $1.50.

THE TENDENCY TOWARD PROGRESSION OR PERFECTIVE DEVELOPMENT IN PLANT EVOLUTION

STUDIES IN DETERMINATE EVOLUTION No. IX

JOHN H. SCHAFFNER

After any extensive study of certain fundamental characters or processes in a general taxonomic plant series, a very remarkable tendency becomes evident in that when a new reaction is introduced into the evolutionary movement, it is often much less definite and certain at first than it becomes in forms which plainly belong to a higher general level of organization. This movement toward perfection was evidently recognized long ago by Aristole who must be regarded as a genuine evolutionist. He said that: "Nature produces those things which, being continually moved by a certain principle contained in themselves, arrive at a certain end."

Among the first or perhaps the first of the modern evolutionists to declare an internal force or cause for evolution was the botanist Naegeli. He postulated an internal or innate tendency toward progression and perfect development or a so-called principle of perfection in the evolutionary process, and because of this tendency, according to Naegeli, organisms are constantly varying in such a manner as to rise in the scale of nature.

According to Naegeli, the fact of a progression in the past requires an internal tendency to rise. Darwin's answer to this was that natural selection would also imply progression. But it is evident that if the progression from a lower to a higher, from a less perfect to a more perfect condition were caused by selection, the whole series should not be present but only the more perfected; for the selection of the fittest implies the elimination of the unfit. There can be no selection without elimination. Thus the fact of endless numbers of close, progressive series is a direct refutation of both Lamarkism and Darwinism, since the entire series may be present in the same general environment. A careful study of the taxonomic

*Papers from the Department of Botany, The Ohio State University, No. 352.

system also shows that many of the most definite group characters can have no special adaptative value, can have no special use whatsoever. Whether a flower has a trilocular, bilocular, or unilocular ovulary can be of no special advantage either to the biological relations of the individual or to the individual in relation to its physical environment. Very generally the progressive phylogenetic series does not at all correspond to any ecological zonation. If Lamarkian evolution were in operation, the series should correspond with ecological zonation of habitats, regions, altitudes, latitudes, and other ecological conditions. There plainly is no such correspondence. Furthermore, our recent knowledge of mutation shows that evolution proceeds through individuals and not through the race in general, otherwise the old race would have to disappear in the evolution of the new, and there could not be a series of closely related groups.

Of course, it is evident that if there are orthogenetic series and that they have no general relation to corresponding environmental conditions, the very fact of such orthogenetic series shows that a progressive or perfective principle is involved, and this would not be dependent on the order of appearance or relationships of the units evolved in the series. The fact of the series is immediately of more importance than the order of its production. The progressive movements may be useful or not, or they may even occasionally be decidedly disadvantageous to the individual but may nevertheless continue because associated with compensating conditions. On every hand, one meets structures that the idealist would immediately pronounce perfect as compared with less elaborated types farther down the series. What we wish to consider is the fact that very many evolutionary progressions do become more perfect as one advances in the ascending scale of organism and structure. There is not only improvement, step by step, but the reaction becomes more decided, more definite, more prompt, until failure of expression is practically impossible unless something entirely new is added to the system, which may interfere with the given reaction. This evolutionary improvement of a given reaction must be due to one of two causes, either the structural elements of the protoplasm on which the reaction depends become more perfected in their mechanism or else a greater number of similar units, having the same influence in growth and hereditary expression, are

produced whose combined influence then gives a more vigorous and more dependable action.

In recognizing the fact of a progressive, perfective process and principle in the evolution of potentialities, one is not to postulate or subscribe to an "entelechy" or "elan vital" as an hypothesis to cover our present profound ignorance of the real nature and structure of the protoplast and its evolution. It is sufficient, at present, to study the actual series and their direct implications, which if properly done will keep biologists busy for some time without indulging in speculations for which we have had, up to the present, no adequate accumulation of proper investigations. We know that the evolution of the automobile, for example, is due to the creative activity of the human mind, but we do not on that account endow the automobile with a mind or evolutionary force, to explain the intricacies of its organization. The quest for ultimate causes or an Ultimate Cause does not belong directly to the realm of science but is a philosophical-theological discipline. From the very nature of the case no scientific causal explanation of evolution is possible.

The old unscientific, causal, evolutionary hypotheses, like "chance" or "fortuitous variation," "direct action of the environment," "use and disuse," and "natural selection" must be disregarded and allowed to die a natural death, because they are not only unscientific but are contradicted on every side by the realities of the taxonomic systems; as becomes evident when these are studied in their entirety and in relation to their ecological conditions. Some would-be philosophical scientists are still under the delusion that evolution is primarily concerned with the "origin of species." Speciation has little to do with the real problem of evolution as O. F. Cook pointed out over thirty years ago.

PROGRESSION IN DEFINITENESS OF DIFFERENTIAL EXPRESSION IN SPOROPHYLL AND FOLIAGE LEAF

In the lower ferns there is no apparent difference between sporophyll and sterile foliage leaf except that the former produces sporangia on its surface and the latter does not. But as one follows out certain evolutionary lines, a very decided dimorphism gradually appears until the two leaves may have very different aspects and characteristics. Thus in *Onoclea sensibilis* L., belonging to the Polypodiaceae, we have rather

an extreme example of dimorphism. This fern shows its advanced character also in having unisexual gametophytes instead of the usual hermaphroditic condition. Now, although the dimorphism is decided, intermediate expressions between sporophylls and foliage leaves are frequently found, and these appear in all gradations from one extreme to the other.

In the Osmundaceae, which represent the lowest family of the Filicales, a rather similar evolutionary movement has taken place. In *Todea barbara* Moore there is little difference between the pinnae which bear sporangia and those which are sterile. But in the extreme species, *Osmunda cinnamomea* L., the dimorphism between foliage leaf and sporophyll is nearly as decided as in Onoclea. Here again intermediate expressions are quite common and it is not difficult to find leaves that are halfway expressions between the two. Apparently a very little disturbance in the ecological-physiological conditions in which the protoplasts are functioning causes a confusion in the hereditary reaction system. Now, as one goes up the phylogenetic scale into the higher plant series one finds not only that there is a still greater dimorphism between foliage leaf and sporophyll but also that intermediate expressions are exceedingly rare or practically nonexistent. It is only when unusual mutative changes have occurred that intermediate expressions may again appear and these, of course, are then not the result of fluctuating expressions. In the highest plants the physiological processes which give rise to the one expression or the other begin in a definite direction and continue thus to the end of the development of the given leaf, whether sporophyll or foliage leaf.

EVOLUTION OF DEFINITENESS OF DETERMINATION OF THE FLORAL AXIS

The lowest flowers, which represent the first stages of determinateness of the reproductive sporophyll-bearing axis, illustrate the principle of perfective evolution in a very convincing manner. In the lowest living vascular plants, as in the lower lycopods and ferns, the reproductive axis is entirely indeterminate, giving rise indefinitely to successive zones of foliage leaves and sporophylls. From this primitive condition the flower, or determinate sporophyll-bearing shoot, has evolved. The causal factor, therefore, for flower production is determinateness of the reproductive bud. Some potentiality is added

to the protoplast which induces the determinate growth and final death of the bud involved. Now the remarkable thing about this floral evolution is the fact that at first, in the lower levels, the factor or factors of determination act very slowly so that large numbers and usually very variable numbers, are produced before determination of the flower is accomplished. Again, just as in the foliage leaf, the determinate action is frequently inhibited. A small deviation from the normal physiological gradient is enough to induce failure of the determination potentiality and proliferation is the result. In other words, the reproductive bud fails in its determinate process and indeterminate growth continues beyond the reproductive zone just as in plants which have not acquired the reproductive determinate potentiality. The potentiality cannot be depended upon. Proliferation is quite frequent in such low homosporous flowers as *Lycopodium obscurum* L. and *L. complanatum* L. It is also very abundant in some of the lower species of the Equiseta, namely, in *Equisetum fluviatile* L. Frequently also a second cone appears at the end of the proliferated axis, and this second cone may proliferate again. Proliferation of the flowers is frequently seen in some of the lower living conifers, as in both staminate and carpellate cones of *Araucaria angustifolia* (Bert.) Ktz. and the carpellate cones of *Cunninghamia lanceolata* (Lamb.) Hook. The carpellate cones of *Larix kaempferi* (Lamb.) Sarg., *L. decidua* Mill., and *L. laricina* (DuR.) Koch. proliferate occasionally. Proliferation of the flower is also met with occasionally in low types of angiosperms, as in species of Ranunculus, Rosa, and Pyrus. Now in passing along any of the main evolutionary flower series one finds that the determination becomes continually more prompt until at the ends of the series only a few floral parts are produced, in the extreme cases only one, before determination is completed and also that the number of parts is practically without fluctuation. Furthermore, the possibility of proliferation as an ordinary fluctuation is practically eliminated. The determinate reaction gains on the ontogenetic progression, step by step, through the general evolutionary series, in all lines, until in the extreme types the limit is reached when the center of the reproductive bud stops in its growth even before a single incept of any lateral floral organ is in evidence. The evolution of completeness, promptness, and reliability of determination is most remarkable when compared with the variability and

unreliableness of determination in the primitive types of flowers. The failure of prompt determination in the lower types of flowers is also shown in a special way in such groups as Equisetum and Zamia. In the lower species of Equisetum there is a prominent vegetative point at the tip of the cone. In the more advanced series, this point disappears through the more prompt action of the determinate process after the reproductive reactions cease. In *Zamia furfuracea* L. f. also there is a prominent vegetative point on the carpellate cone, associated with a very variable spiral system, while in the higher conifer levels as in *Sequoia washingtoniana* (Winsl.) Sudw. the carpellate cone, which has a 3–5–spiral system but a much more shortened floral axis, has no such point developed. We see then that the evolution of the flower is a vivid demonstration of the perfective principle in evolution, since the reaction advances from a slow movement to a very prompt movement, from a variable action to a mathematically exact reaction, from a frequent failure of action to a dependable action with failure reduced to zero.

IMPERFECT DETERMINATENESS IN CERTAIN INFLORESCENCE HEADS

In the evolution of the inflorescence to a head, there may be the same lack of prompt determination of the inflorescence axis in the lower species as has been seen in the case of the flower axis. If one studies the evolutionary series in which racemes or panicles are the prevailing types but which have at the end just attained to the condition of having head inflorescences, proliferation is a frequent phenomenon. Thus in the Lamiaceae, the more common condition is to have the flowers axillary, or in racemes, panicles or spikes. In a few genera, however, heads have evolved, as in species of Koellia and Monarda. *Koellia pilosa* (Nutt.) Britt has proliferated heads occasionally and both *Monarda fistulosa* L. and *M. didyma* L. have been seen to proliferate frequently. The Dipsacaceae represent one of the lower families of the Compositales in which great group the inflorescence shows evolution from an elongated head to a very flat disk. Such inflorescences as those of Dipsacus and Scabiosa represent the lower levels while Aster and Leontodon are on the advanced level of disk development. *Scabiosa atropurpurea* L. has frequent proliferation of the head while such a condition is not developed in

the higher Helianthaceae and Cichoriaceae. Again as in the flower, the proliferation of the more primitive heads indicates that the beginning of any important evolutionary movement is usually less stable and less dependable than the more advanced developments in the same phyletic line.

PEDUNCLES AND PERIANTHS IN EQUISETUM

In the lower vascular plants with primitive flowers, there are no special hereditary potentialities that can come into play in the transition zone between the vegetative axis below and the reproductive axis above, but as we ascend the evolutionary ladder the protoplast acquires a greater and greater accumulation of hereditary potentialities, some of which will be of such a nature as to be thrown into activity on this transition zone. Thus peduncles and perianths soon come into prominence although the lowest species have no such structures. In Equisetum a sterile calyx is thus evolved. In the lowest species of Equisetum the calyx whorl has sporangia in its segments on the upper side while in the higher types, like *E. scirpoides* Mx. and *E. arvense* L., it is completely sterile. But since the evolutionary movement in this respect is not very far advanced, about one out of about every 20 cones in *E. arvense* will have one or more sporangia on the calyx. In a high type of flower, like a Geranium or a lily one would have to hunt a long while before a flower appeared with sporangia on the perianth segments. Only with a special evolution, like a very rapid advance of the time of flower determination in the ontogenetic sequence, would it again be possible to have a confusion of this kind. In Equisetum also the reactions which produce sterile and fertile shoots are not very strongly determined and thus every degree of semisterile cone between a perfect cone and vegetative tip may be easily found in most species. Again in the highest species of Equisetum, *E. arvense*, these intermediate cones are quite rare. The bud usually produces a fertile shoot with a normal cone or a sterile shoot with a vegetative tip. In the higher flowering plants such intermediate developments do not occur unless as the result of extreme mutations or some such special cause. The factors which are responsible for floral shoots or leafy shoots act promptly and decidedly so that no half-way structures are produced unless a decidedly disturbing, new hereditary potentiality has previously been introduced into the system. The lowest species of Equisetum

have no definite peduncle developed below the cone while in the higher a very variable peduncle is present. In *E. arvense* the peduncle may fluctuate from one-fourth inch to more than five inches in length.

PROGRESSION FROM FIVE–PARTED TO FOUR–PARTED FLOWERS IN DICOTYLS

Although a few of the dicotyl series begin with a trimerous system in the flower, the general rule is a pentamerous type as the basal structure. Frequently then there is a direct mutation to the tetramerous type. In this common progressive change the principle of perfective evolution is also prominently in evidence. A few selected examples are given below. In the Celastraceae, *Celastrus scandens* L. has the usual five sepals, five petals, and five stamens. In the genus Euonymus, the flower has mutated to the four-part condition. Now in *E. obovatus* Nutt., the sepals, petals, and stamens are usually five each; but occasionally a four-parted flower is produced beside the five-parted ones. A mutation has been accomplished in the species but this new factor acts only occasionally in a special physiological condition which arises in the same cell complex as the condition which leads to five-parted flowers. In *E. atropurpureus* Jacq., the flower is usually four-parted, but sometimes five-parted flowers are produced along with the four-parted in the same cluster. In *E. europaeus* L. and *E. alata* Regel, the flowers are four-parted and only rarely is a five-parted flower developed on the plant. Finally in a related genus, in *Pachystima canbyi* Gr., the flower is regularly four-parted with four sepals, four petals, and four stamens. The potentialities responsible for the four-parted reaction have become perfected so that there is no failure.

Ruta graveolens L. has four-parted flowers, but usually the central flower of each main branch of the flower cluster has a five-parted flower. The mutation does not work in the central gradient. The Tubiflorae are characteristically a group with pentamerous flowers and this is true for part of the Gentianales, but in the Oleaceae, the flower has mutated to a four-parted perianth. Now in the common lilac, *Syringa vulgaris* L., although the flowers are mostly of this type, very many of the panicles show flowers with a five-parted perianth, usually at the end of the panicle or toward the center of some of its branches. In mutating to the four-parted condition, the plant

did not loose the potentialities which produce five-partedness. Occasionally a three-parted flower is produced. The factors which change the reaction of the flower bud from a five-parted to a four-parted condition bring about a further reduction, which indicates that a further mutation might occur which would give rise to a three-parted lilac. In the golden-bell (Forsythia), five-parted flowers are less common than in the lilac.

The Crassulaceae also show a fundamentally pentamerous condition of the flower, but with a strong tendency to mutate to a tetramerous condition. Many of the genera have flowers of both types. Some of the genera have five-parted flowers regularly. In *Sedum triphyllum* (Haw.) S. F. Gray and *S. telephioides* Mx., the flower is five-parted, while in *S. acre* L. and especially in *S. ternatum* Mx. the central flower of the cyme is commonly five-parted while those on its branches are four-parted. Thus again, in Sedum we see a mutation to a four-parted condition but the factors involved are not in such a state as to completely prevent the more fundamental pentamerous potentiality from being expressed in certain parts of the inflorescence.

THE PERFECTIVE TENDENCY IN THE EVOLUTION OF ZYGOMORPHY

The lower types of flowers, whether spiral or cyclic, are all radially symmetrical. On the higher levels in most lines of monocotyls and dicotyls, zygomorphy appears and sometimes becomes very extreme. The most fundamental movement in the evolution of zygomorphy is the more prompt determination of one side of the determinate flower bud than the other. Along with this progressive movement, usually, various factors of shape, color, texture, ornamentation, etc., are evolved. As stated, zygomorphy is usually not encountered until the series has advanced to a considerable degree of complexity. However, occasionally a distinct zygomorphy is found even in the primitive spiral stage. Thus in *Pinus radiata* D. Don., *P. muricata* D. Don., *P. attenuata* Lem., *P. sabiniana* Dougl. and other species a decided zygomorphy is produced by the difference in character of the ovuliferous scales on the inner and outer sides. Although the pine cone is a low type of flower it, nevertheless, does have a high degree of complexity of reactions when compared with such simple systems as are

presented by the cones of Lycopodium, Zamia, or Araucaria. In the dicotyls, a prominent development of zygomorphy is known in some genera of Ranunculaceae which represent a very low condition otherwise. The flowers of Aconitum and Delphinium have not advanced beyond the apocarpous stage, yet zygomorphy is pronounced in both calyx and corolla.

The evolution of zygomorphy, like other fundamental movements, shows a decidedly progressive and perfective sequence in many series. Thus a series of genera or species may show a progressive reduction of stamens from 6 to 5 to 3, and then to 2 or to 1; or from 5 to 4 to 2, to 2 halves. In the Scitaminales, Ravenala has 6 stamens, which is the fundamental number for all the Liliiflorae whether hypogynous or epigynous. It has a slight zygomorphy but not enough to eliminate any of the stamens. In its near relative, the banana, *Musa sapientum* L., one stamen is missing in both staminate and carpellate flowers. There is simply an empty space where the stamen should appear on the zygomorphic plane. Now on almost any bunch of banana flowers one can occasionally find this sixth stamen developed in one or more flowers. It may be a perfect stamen or a vestige of any degree of expression. The banana flower has only taken the first step of sufficient size to eliminate one stamen and the condition is not perfected in relation to the general reaction system, and so frequently the original condition is produced which gives six stamens. A little disturbance in physiological condition brings back the original structural type. In the higher Scitaminales there are but five stamens or sometimes only three, all except one of which are changed to showy staminodes. In the two highest families, Cannaceae and Marantaceae, there is an unsymmetrical potentiality introduced which also affects the remaining fertile stamen which is then reduced to a half fertile stamen. The whole flower is now bilaterally unsymmetrical but still shows its complete evolutionary history in its make-up—(1) spiral symmetry, (2) cyclic symmetry, (3) zygomorphic symmetry, (4) inequilateral condition. So far as the andrecium is concerned the evolutionary sequence has attained to its definite determinate limit at the one-half stamen condition. In the Orchidales zygomorphy also brings about a reduction of the stamens from six to one, the very vast majority of orchids, 10,000 or more, having this one stamen in the same position on the zygomorphic plane in relation to the other

parts. Those who still think that there is any fortuity in the fundamental processes of evolution should study the structural relations of this one stamen in the Orchidaceae.

In the Scrophulariaceae there are various zygomorphic reduction series, the stamens running from five to four to two. In the Bignoniaceae, Bignonia, Anisostichus, and Tecoma have four anther-bearing, didynamous stamens with a vestige of the fifth. Paulownia shows the same condition. But in Catalpa the anther-bearing stamens are reduced to two, through the advancement of the zygomorphic evolution, with three prominent vestiges. Now just as in the banana, the two lateral, reduced stamens, especially in *Catalpa speciosa* Ward., sometimes develop normally, giving flowers with four stamens. Occasionally all five stamens develop normally. These four- or five-stamened flowers appear in the panicles along with the characteristic two-stamened flowers. It is not a matter of segregation of old heredity from new heredity but rather the expression of an old suppressed heredity over a more recently acquired heredity potentiality through some local change in physiological activity.

In the Lamiales, the lower types again show the fundamental number of five functional stamens. Then in the Lamiaceae, Isanthus has four didynamous stamens and this is the usual condition of most of the intermediate genera, while Monarda and Blephilia have but two. Finally in Salvia the zygomorphic advancement is extreme and not only gives a zygomorphic calyx and an extremely zygomorphic corolla, but the two remaining stamens also are decidedly affected by the zygomorphy and show a progressive advance so that in the higher species each stamen has but a half anther, the other half being transformed into a peculiar lever-handle. The zygomorphic evolution has advanced to the last possible degree of perfection in so far as it can affect the stamens.

The general trend toward a perfective advancement in the evolutionary process is also prominently shown in the zygomorphic conditions of the closely related families, Cistaceae and Violaceae. The Hypericaceae represent a more primitive, actinomorphic group belonging to the same general series. In Crocanthemum, the flowers have an actinomorphic aspect, but close examination shows that the two outer lateral sepals are smaller and narrower, or sometimes wanting. In Cubelium the flowers are only moderately zygomorphic, the petals being

nearly equal. The lower one is, however, somewhat gibbous, but the andrecium and calyx show little or no zygomorphy. In Viola the zygomorphy becomes successively more and more extreme until in such species as our common blue violet, *Viola papilionacea* Pursh, the petaliferous flowers are extremely zygomorphic, having three distinct types of petals, two very distinct types of stamens and even a somewhat zygomorphic calyx and gynecium. Those who have thought that such a series was produced by natural selection because of the highly specialized character of the flower, with its nectar spur, adapted for insect pollination, should certainly be shocked to find that these highly perfected, zygomorphic, insect-attractive flowers are either completely sterile or produce very few seeds, while the later-developed, cleistogamous flowers, which have no corolla whatever and are entirely self-pollinated, are abundantly fertile and produce great quantities of perfect seed. Such cleistogamy is found in many genera of both anemophilous and entomophilous plants. It is plain that the perfection of the zygomorphy and the showyness of the petaliferous flower were evolved neither through any selective action of visiting insects or other environmental conditions nor through any direct response to an unusual physical environment. One might remark in passing, that to the crude pseudo-science of the past century, such a zygomorphic, showy corolla as is present in the higher types of violets was conclusively an "attractive adaptation to fertilization" and the irregularity of the zygomorphic shape was to provide a suitable landing place for the visiting insects. The evolution of zygomorphy in the Violaceae is accompanied by another interesting development, namely, the elongation of the flower peduncle. In *Cubelium concolor* (Forst.) Raf. the peduncle is ¼–¾ inches long; in *Viola canadensis* L. 1–2 in.; in *V. eriocarpa* Schw. 1½–3 in.; in *V. conspersa* Reich. 2–4 in. These species have aerial leafy shoots while the remaining ones mentioned below have geophilous stems. *V. blanda* has peduncles 2½–5 in. long; *V. cucullata* Ait. 4–7 in.; *V. papilionacea* Prush 4–8 in.

Since there is no advantage to the plant in thrusting its showy flowers up, to the convenience of the pilfering insects, the "adaptation" must be for some other important "use." And in the spring see how readily the children can and do gather these pretty flowers and how "perfectly adapted" they are for making great bouquets! "Adaptation" is a

wonderful thing! In this connection, the "adaptation" to insect pollination of the common milkweeds may be considered. In the Apocynaceae the pollen is glandular, although the pollen-grains are simple, but in the next higher family, Asclepiadaceae, more definite pollinia or granular masses are developed which in Asclepias and other genera become marvelous structures that can only be removed and carried about through the aid of insects. Two flattened, pear-shaped, waxy pollen-masses from two adjacent anthers form a pair suspended on curved threads from a peculiar connective which has a slit in which the proboscis or foot of the unlucky insect is caught and from which it cannot escape without either leaving its leg behind or carrying the whole apparatus with the two pollen-masses away. A more perfect or ingeneous devise could hardly be conceived. Yet this perfected mechanism is so inefficient in inducing pollination of the milkweed flower, that, after a careful statistical study of our common *Asclepias syriaca* L., over a wide extent of territory, it was found that less than one flower in 100, under all ordinary environmental conditions, ever becomes pollinated. The milkweed "adaptation" is about as inefficient a method of pollination as could be devised.

VARIOUS OTHER EXAMPLES OF THE OPERATION OF THE PROGRESSIVE, PERFECTIVE PRINCIPLE

The genus Thalictrum belongs to a family whose flowers are mostly bisporangiate. In Thalictrum, however, there is a gradation series of species running from the perfect condition to a rather decidedly diecious state. *Thalictrum clavatum* D C. has bisporangiate flowers, *T. polygamum* Muhl. usually bears both bisporangiate and monosporangiate flowers. *T. dasycarpum* Fisch. & Lall. is diecious but frequently develops individuals with both kinds of monosporangiate and also bisporangiate flowers, and the sex is easily partially or completely reversed from time to time through ecological control. *T. dioicum* L. is decidedly diecious and individuals with some perfect or completely reversed flowers are comparatively rare. It is also more extreme in its general morphological characters than the other species mentioned. Under experimental control it is also more constant in sex than the other species mentioned above. All species of Thalictrum fall into this series in respect to their sexual conditions. A somewhat similar series is presented by the genus Fraxinus. The genus Acer shows a condition

somewhat similar to Thalictrum. The ancestral type of Acer had bisporangiate flowers as is plainly indicated by the prominent vestigial sporophylls of the opposite sex condition in the flowers of the more primitive species. *Acer plantanoides* L. has prominent petals, nectar glands, large vestiges of the opposite sporophylls, and frequently reverses the sex in either direction, sometimes involving rather large branches. *A. rubrum* L. and *A. saccharinum* L. have small vestiges of the opposite sporophylls but still show frequent sex-reversals, although the phenomenon does not appear to be so common as in *A. plantanoides*. Finally *A. negundo* L., an extreme species in many characters, shows no vestiges of the opposite sporophylls in the flower and also shows sex-reversal very rarely, although such reversal has been reported. There is thus a progressive degree of perfection and constancy in the evolution of the secondary sexual states. Similar conditions have been found in quite a number of other diverse genera, both by observation and by direct experiment. In the genus Acer, there is evident another interesting condition. Acer belongs to a series of groups that are prevailingly tricarpellate. But Acer itself has advanced in the same direction as nearly all advanced dicotyls and has become bicarpellate. Now in various species of Acer, tricarpellate ovularies and fruits frequently appear and sometimes even four perfect carpels may be present. The evolutionary change from three carpels to two carpels is again such that the reaction is not always perfect and a reversion to the more primitive condition takes place, not because of a mutative loss of the factor but merely because of a failure to react properly in the given physiological condition of the cells involved. Thus the old reaction, which was never lost, comes into play again. Similar reversions are seen in many other plants. *Juglans regia* L. frequently has tricarpellate gynecia.

Another good example of the imperfect development of an important potentiality in its first phylogenetic stages is the genus Arisaema. The lowest Aroids have bisporangiate flowers while the remaining ones are monecious with the exception of Arisaema, which contains both monecious and diecious species. In some of the monecious species, as in *A. dracontium* (L.) Schott., the plant is easily reversed from moneciousness to a staminate condition or from staminate to monecious. With greater difficulty the monecious condition can be caused to

approach a nearly complete carpellate condition. *A. triphyllum* (L.) Torr. is more decidedly diecious and is perfectly balanced so that the sex-reversal can be easily induced in either direction from the one sexual state to the other or to moneciousness. It is said that some species of Arisaema are much more stable in their sexual states than is *A. triphyllum.*

The perfection principle and orthogenetic series are again illustrated by the splitting of the husk of the fruit in the genus Hicoria. In *Juglans regia* L. the husk separates from the nut or pit as in a hickory but does not split. In *Hicoria cordiformis* (Wang.) Britt. the husk is tardily four-valved. In *H. microcarpa* (Nutt.) Britt. the husk splits tardily and incompletely to the base. In *H. villosa* (Sarg.) Ashe. the husk splits partly to the base. In *H. ovata* (Mill.) Britt. the husk is thick and soon splits into four valves to the base. In *H. carolinae-septemtrionalis* Ashe. the husk soon splits completely and falls readily into four valves or pieces.

The Nymphaeales as well as certain other groups show a progressive, perfective series in the evolution of staminodes. In Brassenia and Cabomba, which have the lowest apocarpous, hypogynous type of flower, there is no sign of any disturbance between the perianth and andrecium. In *Nymphaea advena* Sol., with a syncarpous, hypogynous flower, there is a slight development of staminodes at the base of the andrecium, usually confined to the outermost members. These stamens are slightly enlarged, flattened structures which still show vestigial microsporangia and have only a slight degree of petal characteristics. In *Castalia odorata* (Dry.) W. & W., which has a syncarpous flower in the first stage of epigyny, there is a prominent zone of staminodes, ranging from typical petals at the outer margin to typical stamens at the inner margin, between the true corolla and the normal stamens. Finally in *Victoria regia* Lindl., which belongs to the epigynous Nymphaeaceae with epigynous hypanthium, the development of petal-like staminodes is more extreme even than in Castalia.

In the Apocynaceae and Asclepiadaceae, the bicarpellate ovulary undergoes a characteristic splitting which sometimes includes even part of the style. These separated carpels develop into two follicles. The splitting is a secondary character evolved in the syncarpous condition. In some Apocynaceae the carpels are not thus split apart but continue in the same general condition as all the lower Tubiflorae.

Apocynum is a genus in which definite splitting occurs. Now in studying the development of the fruit of species of this genus it was found that *A. cannabinum* L. sometimes develops fruit to maturity without any splitting taking place. This again illustrates the principle that those groups or species which represent the first steps of an evolutionary series do not have the potentiality in as definite and perfect a state as those more advanced in the series. In Asclepias the splitting apparently occurs regularly, although no extensive observations have been undertaken to determine this definitely.

In both Monocotyls and Dicotyls, the co-ordinating reactions in the stem bud, which determine the position of the leaves, frequently indicate a definite evolutionary movement from a several-spiral condition to a two-ranked condition or unaspiral as the determinate culmination type. The Monocotyl lines nearly all end in a unaspiral. The three closely related genera of Fagaceae, Quercus, Castanea, and Fagus, show a perfective movement toward a definite, two-ranked reaction potentiality. *Quercus muhlenbergii* Engelm. and other species do not have a two ranked leaf arrangement but a typical 2–3 spiral system. The winter bud scales also indicate a primitive condition, having a 2–3 spiral system with 5 spiral radii in evidence. In *Castanea dentata* (Marsh.) Borkh. some of the twigs have two-ranked leaves and some have a more primitive spiral system like the oak. The two kinds of branches appear on the same tree. The potentiality for two-ranked has been acquired but often fails to come into play. In *Fagus grandifolia* Ehrh. the leaf arrangement is regularly and perfectly two-ranked under all ordinary conditions. In this series the movement is from no two-ranked potentiality, to a potentiality for the two-ranked expression which is decidedly unreliable and indefinite, to a two-ranked potentiality which is of such a nature that the hereditary expression is perfect in all ordinary physiological-ecological conditions. The characters of the fruit cups and involucres and of the staminate catkins also determine the progressive phylogenetic series as (1) Quercus, (2) Castanea, (3) Fagus independently of the orthogenetic series shown by the leaf arrangement.

THE PERFECTION PRINCIPLE ILLUSTRATED BY THE EVOLUTION OF AN ISOBILATERAL SYSTEM

The typical isobilateral flower is a rare type. It is ideally developed in the Fumariaceae. This type of symmetry is

gradually evolved as one passes from the lower Papaveraceae into the middle of the Fumariaceae. It is also developed in the Brassicaceae and Capparidaceae but not to such an extreme condition. An isobilateral flower or organ may be defined as one that can be cut into equal halves by two planes, intersecting at right angles, the halves of the one plane being unlike those of the other. In typical cases there is a reduction in the one plane as compared with the other. Often, both the number of parts and the forms and peculiarities of the non-corresponding halves are different.

In the lowest Papaveraceae, the entire flower shows nothing but the primitive spiral and cyclic, radial symmetry. There is no evidence of bilaterality of any kind. *Romneya coulteri* Harv., the matilija poppy of southern California, is described as having constantly 3 sepals, 3+3 petals, many stamens, and numerous united carpels. I have not had the opportunity to study this species. *Platystemon californicum* Benth. has a similar structure with 3 sepals, 3+3 petals, 42, more or less, stamens, and 6–18 carpels.

In *Argemone intermedia* Sweet, White Prickly-poppy (Figs. 1, 2), a common species of the western prairie and plains, the majority of flowers on a plant usually have the primitive trimerous perianth, 3 sepals, and 3+3 petals, with a very variable number of stamens, 184–336, and 2–6 carpels. Fig. 1 represents a typical actinomorphic flower, while Fig. 2 represents a rather reduced isobilateral type. These two types of flowers occur on the same plant but the radially symmetrical ones are much more abundant than the isobilateral ones. The species represents a plant that has taken the first step toward the isobilateral condition and the new character is very unreliable in expression. It is not a matter of hereditary segregation but one of hereditary expression, and the old trimerous heredity in the great majority of flower buds comes to activity rather than the new. The principle of imperfection is strikingly in evidence.

The commonly cultivated oriental poppy, *Papaver orientale* L. (Figs. 3, 4) is somewhat farther along the road toward isobilaterality. Sometimes the flowers with actinomorphic perianths and with isobilateral perianths are produced about equally, but at other times either the isobilateral or the actinomorphic type is the more abundant. As in *Argemone intermedia* both types of flowers are commonly produced on the same

plant. In the general advancement of determinateness the oriental poppy is still in the more primitive condition both in respect to stamens, 390–450 ±, and carpels, 10–15 ±.

The more typical poppies have an isobilateral perianth with 2 sepals and 2+2 petals quite regularly. *Papaver dubium* L. (Fig. 5) is of this type, with an isobilateral perianth, 232 ± stamens, and 7 ± carpels (6–10). In general the flower is decidedly reduced when compared with *P. orientale.*

In *Stylophorum diphyllum* (Mx.) Nutt. (Fig. 6) the flower again shows a decided reduction over that of *Papaver dubium,* having 2 sepals, 2+2 petals, 72 ± stamens and only 4 carpels, or sometimes these are reduced to 3 or 2. *Chelidonium majus* L. (Fig. 7) is approaching quite near to the perfect isobilateral type with 2 sepals, 2+2 petals, 2 carpels and only 16 ± stamens (14–24).

Passing over to the Fumariaceae, we find the isobilateral symmetry perfectly developed. In the Dutchman's-breeches, *Bicucula cucularia* (L.) Millsp., the flower (Fig. 8) has 2 sepals, 2+2 petals, 2+4 stamens and 2 carpels. The isobilateral movement has finally attained mathematical perfection. The two outer petals are spurred while the two inner ones have no spurs. A somewhat similar condition is developed in some Brassicaceae, but to a decidedly less extent, as in *Cheiranthus cheiri* L., *Ricotia lunaria* DC., and *Lunaria annua* L. While the flower has progressed to ideal isobilaterality, the fundamental progression of more prompt determination of the floral axis in relation to the beginning of the reproductive reactions has continued, and in the Bicucula type the upper 4 stamens are reduced as compared with the 2 lower ones, having only 2 microsporangia while the lower ones have the usual 4 microsporangia. This is a characteristic example of the way characters evolve as the result of some fundamental orthogenetic movement and not through natural selection in a life and death struggle nor as a response to use and disuse. It would certainly require a marvelously credulous mind to see any advantage in having the 2 outer stamens developed with 4 sporangia and the 4 inner stamens with only 2 sporangia each. This peculiarity is present in other genera of the family. Great numbers of similar situations are in evidence when one makes a proper taxonomic analysis of the various plant groups. Now the general orthogenetic movement of the time of floral determination could be carried still further and there are genera with

more reduced numbers. In the Brassicaceae the isobilateral flower is sometimes reduced to the formula—sepals 4, petals 0, stamens 2, carpels 2, as in *Lepidium ruderale* L.

In the Fumariaceae, a new evolutionary trend is introduced in some species, namely, a zygomorphic potentiality which is imposed upon the isobilateral condition. A typical example is presented by *Capnoides aureum* (Willd.) Ktz. (Fig. 9). Structurally the flower is isobilateral in even a greater degree than in Bicucula, having the 6 stamens united by their filaments into 2 groups. The outer pair of petals show a strong zygomorphy in that one is spurred and the other is not. There is also a nectar gland at the base of the spurred petal and none at the base of the opposite petal. This flower series, therefore, shows the general evolutionary series of the poppy-fumatory group to have progressed from a slow, variable determination to a prompt, definite determination; from spiral to cyclic; from actinomorphic to isobilateral; and finally from the isobilateral to the zygomorphic condition. Usually the advanced movement is from actinomorphy directly to zygomorphy; and then rarely an unsymmetrical condition of form and general expression may be added on top of the zygomorphic condition.

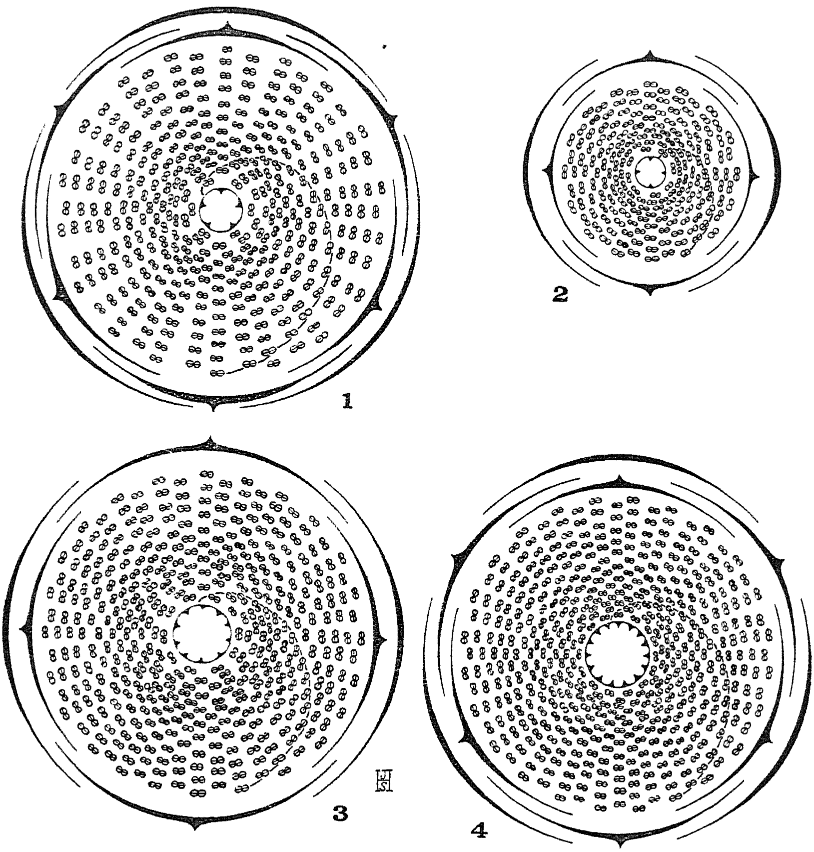
To some, the term perfective, or perfection, more commonly conveys the idea of an immediate ideal goal or attainment; and from a utilitarian standpoint of evolution such might be the inference. But aside from a philosophical attitude one may have in asserting that there is in the organic world a system and principle which does bring about an orderly cosmos and a highly successful balance of nature, this idea should not be entertained in relation to the scientific study of the perfective development of characters and properties of organisms. As intimated in at least one example of perfective evolution given above, the result may be a decided disadvantage to the individual in relation to its environment, or the mechanism may be highly perfected and still be of no use whatever to its possessor. In this world, a thief may attain perfection in his calling as well as a saint. However, in its broadest aspects, the general course of evolution is perfective in the ethical and altruistic sense, at least to all people so philosophically inclined as to be able to view the system as a whole.

SUMMARY STATEMENT

There is a manifest tendency toward progression and perfective development in the evolution of many fundamental plant series. This progression in perfection of structures and reactions is not to be ascribed to any selective principle nor to any direct reaction to a series of changing environments, either in time or space, but to some internal cause dependent on the nature of the protoplasm involved.

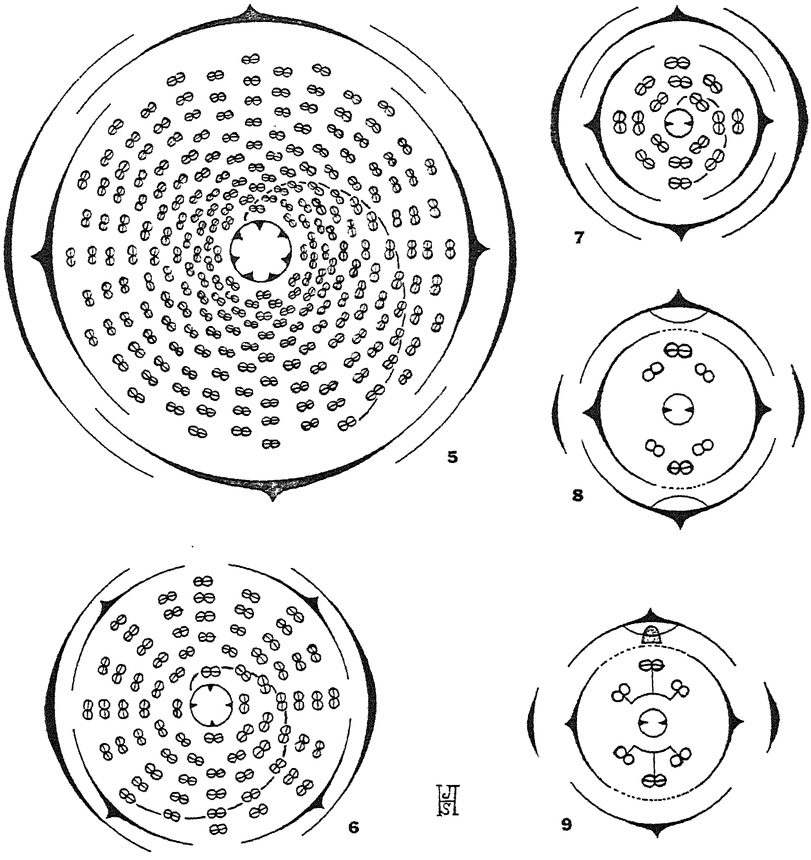
Among the more important examples discussed, in the present paper, of evolutionary series showing progressive, more dependable, and more prompt reaction in passing from the lower to the higher members are the following: Progression in the definiteness of differentiation expression in sporophyll and foliage leaf. Evolution of definiteness and promptness of determination of the floral axis. The more definite determination of the inflorescence axis in the higher as compared with the more primitive types of inflorescence heads. The instability of the reaction on the lower evolutionary levels in passing from a five-parted to a four-parted flower in various dicotyls. The decided perfective tendency in the progressive evolution of zygomorphy. The progressive and perfective series shown in the evolution of the isobilateral type of flower from the more primitive actinomorphic type in the Papaveraceae-Fumariaceae group.

The facts presented, together with a large array of similar phenomena which might be adduced, indicate decidedly the presence of an internal perfective principle operative in the evolution of organisms and that evolution in its fundamental aspects is intrinsic, orthogenetic, progressive, perfective and determinative.



Diagrams of floral structures in the isobilateral series in Papaveraceae and Fumariaceae.

1. *Argemone intermedia* Sweet. Sepals 3, petals 3+3, stamens 336, carpels 5. Actinomorphic.
2. *Argemone intermedia* Sweet. Sepals 2, petals 2+2, stamens 184, carpels 4. Isobilateral.
3. *Papaver orientale* L. Sepals 2, petals 2+2, stamens 390, carpels 10. Isobilateral.
4. *Papaver orientale* L. Sepals 3, petals 3+3, stamens 450, carpels 15. Actinomorphic.



Diagrams of floral structures in the isobilateral series in Papaveraceae and Fumariaceae.

5. *Papaver dubium* L. Sepals 2, petals 2+2, stamens 232, carpels 7. Isobilateral.
6. *Stylophorum diphyllum* (Mx.) Nutt. Sepals 2, petals 4, stamens 72, carpels 4. Isobilateral.
7. *Chelidonium majus* L. Sepals 2, petals 2+2, stamens 16, carpels 2. Isobilateral.
8. *Bicucula cucularia* (L.) Millsp. Sepals 2, petals 2+2, stamens 2+4, carpels 2. Perfectly isobilateral.
9. *Capnoides aureum* (Willd.) Ktz. Sepals 2, petals 2+2, stamens 2+4, carpels 2. Isobilateral-zygomorphic type.

EARTHWORMS OF MISSOURI

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Earthworms are among the most common of our animal forms but they have received very little attention from taxonomists and the fauna of this country is not very well known. Because the natural history of the earthworm is but little known to the average reader, it is commonly regarded as a useless and uninteresting creature, which may occasionally serve for bait. However, earthworms play a very important part in the teaching of zoology and in research, they are used quite extensively for studies of reactions, embryology, histology and regeneration; and to the ecologist they present some interesting problems in distribution.

Our knowledge of the group has chiefly been developed by Michaelsen, Stephensen, Eisen, Vaillant, Vejdovsky, Benham and Beddard, who are responsible for the literature on the Lumbricidae. The literature on North American earthworms is decidedly meager. Several foreign zoologists have worked on American material, but naturally they have been greatly handicapped in securing sufficient collections. Professor Frank Smith has given them more attention than any other American worker. Among other things, he has published (1928) a very complete list of the earthworm fauna of Illinois. The author (1928) published a paper on the earthworms of Ohio with a study of their distribution in relation to the hydrogen-ion concentration, moisture, and organic content of the soil. To my knowledge these are the only regional papers published on North American earthworms. I have not been able to discover a single record for any species of earthworms in Missouri. The present paper is based on my personal collections which have extended into 25 counties of the state during a period of four years. In addition collections were made by various friends and students.

DEFINITION OF TERMS USED IN IDENTIFICATION

Smith (1917) has published a definite system of terms and symbols and his statement with some modification will be adopted for use in this paper.

The limits of somites externally are indicated by the intersegmental grooves between the segments, while internally the septa or partitions serve this purpose. The somites are numbered from the anterior end, not counting the prostomium, which is not a segment. Each somite is designated by arabic numerals. Should the first intersegmental groove be obscure, one can distinguish the second somite, since it is the first to bear setae. The intersegmental grooves for any two adjacent somites are represented by a formulae; 5/6 indicates the groove between segments 5 and 6.

In the Lumbricidae there are eight setae to a somite, and these are usually arranged in pairs, two pairs on each side. They may be closely or widely paired or separate. The setae on either side are indicated by the use of letters, a, b, c, and d. The ventral-most setae is designated by a, the next by b, and the next by c, and the dorsal-most by the letter d. Should the distance between a and b and between c and d be less than one-third of the distance between b and c, the setae are said to be closely paired.

If the prostomium divides the peristomium completely and the longitudinal grooves which form its lateral boundaries extend clear to the intersegmental groove 1/2, the prostomium is said to be *tanylobic*. Should the prostomium and its lateral grooves extend only part of the way across the peristomium and fails to reach the groove 1/2, it is said to be *epilobic*. When the prostomium and the peristomium are entirely fused or coalesced, it is said to be *zygolobic* (Spargonophilus).

On some of the somites of the clitellum along the ventral edges, there are some glandular ridges termed tubercula pubertatis. They may vary as to their position in the clitellar region, and may in some cases be absent. The spermathecae are pouches which may open to the exterior and receive the sperm cells from the individual. They vary in position, and in some species are totally absent. The oviducal pores are on somite 14 in the Lumbricidae. The spermiducal pores are usually on somite 15, but in some of the Lumbricidae they are present on somite 13.

FAMILY LUMBRICIDAE

This family has eight setae per somite. The anterior border of the clitellum is posterior to the spermiducal pores which in most cases are on somite 15, but in few cases are from

KEY TO THE EARTHWORMS OF MISSOURI

Clitellum	Tubercula pubertatis	Prostate pores	Spermaducal pores	Spermathecal pores	Sperm sacs	Setae	Number of Somites	Length (cm)	Color antero-dorsal	Name
13–18 sad.		18, 20	19	7/8, 8/9	9, 12	Wide	135–160	20–27	Brown	*Diplocardia riparia*
13–18 sad.		18, 20	19	6/7, 7/8, 8/9	9, 12	Wide	125–160	18–30	Pale	*Diplocardia communis*
13–18 cing.		18, 20	19	6/7, 7/8, 8/9	9, 12	Wide	90–120	5–10	Pale	*Diplocardia singularis*
22, 23–36, 27	23–25, 26		13	9/10, 10/11 dorsal	9, 11, 12	Close	80–100	4–6	Brown	*Helodrilus tetraedrus* f. *typica*
22, 23–27	23–25, 26		15	9/10, 10/11 dorsal	9, 11, 12	Close	80–100	4–6	Brown	*H. tetradrus* f. *hercynius*
22–29	None		15	None	11, 12	Close	100–110	4–7	Brown-red	*H. gieseleri* var. *hempeli*
25, 26–32	29–31		15	9/10, 10/11	9–12	Close	130–150	4–8	Pale red	*H. roseus*
24, 25 or 26–32	28–30, 31		15	9/10, 10/11	9–12	Close	75–125	5–15	Brown & Buff (bands)	*H. foetidus*
26–31	28–30		15	9/10, 10/11	9, 11, 12	Wide	80–125	5–8	Red	*H. subrubicundus*
26–31	29, 30 (indistinct)		15	None	11, 12	Wide	90–110	4–8	Red	*H. tenuis*
27–34, 35	31, 33		15	9/10, 10/11	9–12	Close	100–250	5–20	Rose-red	*H. caliginosus* f. *typica*
27–34, 35	31–33		15	9/10, 10/11	9–12	Close	100–250	5–20	Rose-red	*H. f. trapezoides*
27–37	None		15	None	11, 12	Close	110–140	10–12	Chestnut-brown (purplish)	*H. zeteki*
27–32	28–31		15	9/10, 10/11	9, 11, 12	Close	90–145	7–13	Reddish-brown (violet)	*Lumbricus rubellus*
29–37	31, 33, 35		15	8/9, 10/11	9–12	Close	80–125	5–7	Greenish	*H. chloroticus*
30–35	31–34		15	9/10, 10/11	9–12	Wide	100–170	5–16	Pale-pink	*Octolasium lacteum*
31, 32–37	33–36		15	9/10, 10/11	9, 11, 12	Close	125–175	15–25	Brown-violet	*Lumbricus terrestris*

one to three somites further anterior. The calciferous gland is situated in the region of the gonads. A gizzard is present at the anterior end of the intestine. There are no typical prostate glands extending free into the coelomic cavity. The spermaries and spermiducal funnels are in somite 10 and 11. The ovaries are in 13. The oviducal pores are in 14.

HISTORICAL

The genus *Lumbricus* and the old *genus Allolobophora* are practically the only important terrestrial genera of the Oligochaetous worms prevalent in North America and Europe. Michaelsen (1910), in a discussion and revision of various genera of Lumbricidae, reduced the genera to three. They are *Helodrilus*, *Lumbricus*, and *Octlasium*, and are widely distributed in all parts of the world except in the tropics, and are especially abundant in the United States. Smith (1928) listed 18 species in this family for the state of Illinois. The author (1928, 1933) listed 19 species for the state of Ohio.

Genus **Lumbricus** Linneaus (1758) Amended Eisen (1874)

Prostomium completely divides peristomium and longitudinal grooves which form its lateral boundaries extend to inter-segmental groove 1/2 (tanylobic). Spermaries and spermiducal funnels inclosed in sperm vesicles. Sperm sacs are in 9, 11, and 12. Setae closely paired posterior to clitellum.

Lumbricus terrestris Linnaeus (1758)

Length 15 to 25 cm. Somites 125 to 175. Color, anterior dorsal surface, brownish blue, reflecting prominent greenish-violet color. Clitellum covers somites 32 to 37, and may begin on somite 31. Tubercula pubertatis on 33 to 36. Prostomium, tanylobic. Setae closely paired. First dorsal pore on 7/8. Oviducal pore on 14, slightly dorsal to b. Spermiducal pores on 15, between b and c. Spermathecal pores on 9/10 and 10/11, in line with cd. Spermathecae in 9 and 10. Sperm sacs in 9, 11, and 12. Longitudinal partitions of the calciferous gland, 70 to 75 in number. Septa, 6/7–9/10, strongly, and 10/11–14/15, moderately, thickened.

This species is widely distributed in Europe and has been reported in North America, from Massachusetts, New York, Maine, Connecticut, Maryland, District of Columbia, Michigan, Colorado, California, Illinois, and Ohio. In Missouri it has been collected from St. Louis, Franklin, Marion, Lewis, Adair, Cooper, and Cape Girardeau counties. This species has not been listed in Missouri heretofore.

Lumbricus rubellus Hoffmeister, 1843

Length 7–13 cm. Somites 90–145. Color, reddish brown or deep violet; color more pronounced on the anterior dorsal surface. The clitellum covers somites 27–32. Tubercula pubertatis on 28–31. The prostomium is tanylobic. Setae closely paired. The oviducal pore is on somite 14, slightly dorsal to b. Spermiducal pores on 15. Spermathecal pores on 9/10 and 10/11, in line with cd. Sperm sacs in 9, 11, and 12. There are about 60 longitudinal partitions of the calciferous gland. Septa 6/7–8/9 somewhat thickened; others but very little, with the exception of those in the regions of the sperm sacs. Spermathecae are in 9 and 10.

This species is usually collected among debris. It is widely distributed in Europe and Siberia, and in North America it has been reported from Newfoundland, California, Oregon, Washington, Michigan, and Ohio. It has been collected in St. Louis county. This species has not been listed in Missouri heretofore.

Genus **Helodrilus** Hoffmeister, 1845

The species of this genus are distinguished by the absence of special sperm vesicles enclosing the spermaries and the spermiducal funnels.

The following are subgenera for North America: *Eiseniella*, *Eisenia*, *Allolobophora*, *Dendrobaena*, *Bimastus*. A description of each of these will be given under the subgeneric heading.

Subgenus **Eiseniella** Michaelson, 1900

Michaelsen (Oligochaeta in "Das Tierreich") considered *Eiseniella* a genus. This group was later reduced to subgeneric rank by Michaelsen in 1910 when considered *Eiseniella* very closely related to the subgenus *Eisenia*. So closely related are they that the only character used as a basis for their separation is the somewhat shorter gizzard which is chiefly restricted to the 17th somite in *Eiseniella* and ordinarily involves, in addition, more of the 18th in others. The position of the oviducal pores is also a significant character. Smith states that the American material of *Helodrilus tetraedrus*, *H.t hercynia*, and Eisen's *Tetragonurus pupa* has shown that in every specimen examined the oviducal pores open slightly dorsal to b, as they do in all the Lumbricidae. *Eiseniella* differs from other subgenera, except *Eisenia*, in having the pores of the paired spermathecae between the setae line d and the mid-dorsal line.

Helodrilus (Eiseniella) tetraedrus (Savigny) 1826, forma **typica** Michaelsen

Length of specimens 4–6 cm. Somites 80–100. Color usually some variable shade of brown. Prostomium epilobic. Setae closely paired. Clitellum situated on somites 22 or 23–26 or 27. Tubercula pubertatis on 23–25, seldom on 26. First oviducal-pore on 4/5. Spermiducal pores on 13. Oviducal pores on 14th somite, usually situated mesad of a. The spermathecal pores on 9/10 and 10/11 between d and mid-dorsal line. Septa 7/8–11/12 are slightly thickened.

Calciferous gland poorly developed compared to other Lumbricidae and longitudinal partitions narrow. Sperm sacs in 9–12. Spermathecae on dorsal side, chiefly in 9/10 and 10/11.

Helodrilus tetraedrus, forma *typica* usually found in water-soaked banks of streams, lakes and ponds. It has been collected in Europe and in many parts of the world where Europeans have settled. In the United States it has been reported in Indiana, Pennsylvania, California, Michigan, Colorado, Washington, Illinois, and Ohio. This species has been collected in the following Missouri counties: Jackson, St. Louis, Cape Girardeau, Scott, Jackson, Phelps, Osage, Adair, Shelby and Boone. This species has not been listed in Missouri heretofore.

Helodrilus tetraedrus forma **hercynia** (Michaelsen), 1890

This variety is very similar to that of *Helodrilus*, f. *typica* except that the spermiducal pores are on 15 instead of 13.

It has been collected in the same habitats as *typica*. In the United States it has been reported in Illinois and Ohio. The writer has collected this species from St. Louis and Cape Girardeau counties. It has not been listed in Missouri heretofore.

Subgenus **Eisenia** Malm, 1877

The characters used as a basis for separation of the *Eiseniella* from *Eisenia* are as follows: shorter gizzard, which is chiefly confined to the 17th somite in *Eiseniella*, while in *Eisenia* it ordinarily involves more of the 18th; the location of the spermathecal pores, which are very near the mid-dorsal line, slightly dorsal to d. The location of the spermathecal pores are alike in both *Eiseniella* and *Eisenia*, and this character alone separates the subgenus from all others except *Eiseniella*. The oviducal pores open slightly mesad to a, instead of slightly dorsal to b, as in all the other subgenera, with the exception of *Eiseniella*.

Helodrilus (Eisenia) foetidus (Savigny), 1826

Length of specimens collected was 5–15 cm. Somites 75–125. This worm has very conspicuous and characteristic coloring, due to transverse purple brownish bands on middle area of somites, and alternating with an almost pigmentless inter-segmental area. Pigment is also lacking on the lateral area of 9–11. Prostomium epilobic 1/2. Setae closely paired. Clitellum begins on 24, 25, 26–32. Tubercula pubertatis on somites 28–30 or 31. First dorsal pore on 4/5. Spermiducal pores on 15, between b and c, and not close together. Oviducal pores on 14, slightly in a dorsal position from b. Spermathecal pores on 9/10 and 10/11, near the mid-dorsal line. Sperm sacs are in 9–12. Spermathecae usually in 9 and 10 and in close relation to septa 9/10 and 10/11. They may be posterior in position to the septa.

This species is the one generally used for experimental biological work and appears in such literature under the name *Allolobophora foetida*. This is due to the fact that it can readily be obtained in all seasons of the year, as it finds very favorable conditions in manure, near stagnant pools, in decayed vegetation, especially where a great deal of moisture is present.

Helodrilus foetidus is widely distributed in various parts of the world. In North America, where it is very abundant, it has been collected along the Atlantic and Pacific coasts, in the Mississippi Valley, Rocky Mountain Region, and Gulf States. In Missouri it has been found in the following counties: Scott, Cape Girardeau, Ste. Genevieve, St. Francois, Jefferson, St. Charles, Macon, Adair, Knox, Marion, Jackson, Stoddard, and Bollinger.

Helodrilus (**Eisenia**) **roseus** Savigny, 1826

Length 4–8 cm. Somites 130–150. Color pale red; the body walls without pigment. Prostomium epilobic 1/2. Setae closely paired. Clitellum begins on somites 25–32 and may involve 24 or 33. Tubercula pubertatis, usually 29–30, occasionally on 30–31. Glandular papillae may have modified genital setae, often including one or more setal bundles of 9, 10, 12, or 13. First dorsal pore on 4/5. Spermiducal pores on 15 near b. Oviducal pores on 14, slightly dorsal to b. Spermathecal pores on 9/10 and 10/11 situated near the mid-dorsal line. Septa 6/7–9/10, thickened considerably; others to 14/15, slightly. Sperm sacs in 9–12. The spermathecae are on the dorsal side of 10 and 11 with short ducts.

This species is widely distributed in Europe and in various parts of the world. In the United States it has been reported in New York, Georgia, Indiana, Louisiana, Arizona, California, Maine, and Ohio. It was found in Ste. Genevieve, Jefferson, and Cape Girardeau counties. This species has not been listed in Missouri heretofore.

Subgenus **Allolobophora** Eisen, 1874

Michaelsen, 1900a, 480, gives the following description for the subgenus *Allolobophora:* "Prostomium is usually epilobic, very seldom tanylobic. Setae are more or less closely paired. Spermiducal pores on 15. Spermathecal pores consisting of two or three pairs in the setal line cd. Gizzard including more than one segment. Testes are seminal funnel free; 4 pairs of sperm sacs in 9–12. Sperm sacs of 10 as large as those of 9 (always?)."

Smith (1917) adds the following: "The setae are more or less closely paired. Sperm sacs, four pairs in 9–12; those of 12 approximately as large as those of 9."

Helodrilus (**Allolobophora**) **caliginosus**, forma **typica**, Savigny, 1826

Length 5–20 cm. Somites 100–250. The color of the anterior dorsal surface is brown-red, which is quite variable in intensity in different specimens. Prostomium epilobic. Setae closely paired, those of the lateral pairs especially. Clitellum situated on somites 27–34 or 35. Tubercula pubertatis on 31 and 33. There are conspicuous glandular papillae which surround the ventral side setae 9, 10, 11 and are usually present on 32–34 and may be absent on 28 and 30. First dorsal pore on 9/10. Spermiducal pores on 15, rather more than half way from b to c. Oviducal pores are on somite 14, slightly dorsal to b. The spermathecal pores on 9/10 and 10/11 are in line with the dorsal

bundles. The septa of 6/7–9/10 are very strongly thickened, while those of 5/6 and 11/12–14/15 are less so. The longitudinal partitions of calciferous glands are about 55–56 in number. Sperm sacs are in somites 9–12. Spermathecae are within the septa of 9/10 and 10/11 and do not extend freely into the somite cavities.

This species was found in Bollinger, St. Louis, Scott, Cape Girardeau, and Boone counties. It has not been listed in Missouri heretofore.

Helodrilus (**Allolobophora**) forma **trapezoides** Duges, 1828

This variety differs from f. *caliginosus* only in the position of the tubercula pubertatis. In *typica* they are on 31 and 33, while in *trapezoides* they are continuous on 31 to 33 inclusive.

Helodrilus caliginosus trapezoides is by far the most abundant and has a very wide distribution in the United States. It is listed for the following counties: St. Louis, Jefferson, Ste. Genevieve, St. Francois, Perry, Cape Girardeau, Scott, Bollinger, Stoddard, Mississippi, and Boone. This species has not been listed in Missouri heretofore.

Helodrilus (**Allolobophora**) **chloroticus** Savigny, 1826

Length 5–7 cm. Somites 80–125. Color more or less greenish. Prostomium epilobic. Setae closely paired. Clitellum on somites 29–37. Tubercula pubertatis consists of three pairs of succer-like elevations on somites 31, 33 and 35. First dorsal pores on 4/5. Spermiducal pores on 15, between b and c. Oviducal pores on 14, slightly dorsal to b. Spermathecal pores on 8/9–10/11, in line with the dorsal bundles. Septa 6/7–13/14 are moderately thickened; those from 9/10 diminish gradually toward the posterior. Sperm sacs in 9/12. Spermathecae are in 9, 10, and 11, extending freely into the somite cavities with the ducts of moderate length.

This species is widely distributed in Europe and various parts of the world. In North America it has been reported from Greenland, North Carolina, Vancouver Island, California, Mexico, Guatemala, District of Columbia, Indiana, Colorado, and Ohio. It has been collected in St. Louis, Macon, and Cape Girardeau counties. This species has not been listed in Missouri heretofore.

Subgenus **Dendrobaena** Eisen, 1874

The characters for this subgenus are as follows: Setae widely paired or separate. Spermathecal pores on 9/10 and 10/11 on setae lines of c and d. There are three pairs of sperm sacs in 9, 11, and 12.

Smith (1917) states that some of these characters are combined with others belonging to other subgenera, breaking the dividing line and making classification difficult.

Helodrilus (**Dendrobaena**) **subrubicundus** Eisen, 1874

Length 5–8 cm. Somites 80–125. The anterior dorsal surface is of a variable red color. Prostomium epilobic 2/3. Setae widely paired. Clitellum on somites 26–31, and may invade 25 or 32. Tubercula pubertatis on somites 28–30. First dorsal pore on 5/6. Spermiducal

pores on 15, between b and c. Oviducal pores on 14, slightly dorsal to b. Spermathecal pores on 9/10 and 10/11, in the setal line c. Septa 7/8 and 8/9 moderately thickened, 6/7, 9/10, 13/14, and 14/15 slightly thickened. Sperm sacs in 9, 11, 12. Spermathecae in 9 and 10, free in somite cavities, with very short ducts which enter the septa near the body wall.

This species is widely distributed in Europe and various parts of the world. It has been reported in North America from Newfoundland, California, Colorado, Canada, Illinois, and Ohio. Collections were made from St. Louis, Cape Girardeau, Macon, Marion, Osage, Randolf, and Adair counties. This species has not been listed in Missouri heretofore.

Subgenus **Bimastus** (H. F. Moore), 1893

In this subgenus the tubercula pubertatis are indistinct or lacking. There are about two pairs of sperm sacs, which are in somites 11 and 12. The spermathecae are normally developed. The clitellum in most of the species under this subgenus does not extend posterior to 32.

Helodrilus (Bimastus) giesseleri var. **hempeli** Smith, 1915

Length 4–7 cm. Somites 100–110. Color of dorsal half of body red-brown, while the ventral half lacks pigment. Setae closely paired. Clitellum situated on 22–29 and sometimes part of 30. Tubercula pubertatis lacking. First dorsal pore on 5/6. Spermiducal pores on 15, slightly dorsal to b. Oviducal pores on 14. Longitudinal partitions of calciferous gland about 40 in number. Sperm sacs are in somites 11 and 12. Spermathecae are lacking.

This species is usually found in decayed leaf material, under logs and rotten wood. It has been collected in Florida, Illinois, Kansas, Texas, Indiana, and Ohio, and in the following counties in Missouri: Greene, Jackson, Clinton, Cape Girardeau, Ste. Genevieve, Perry, St. Louis, Boone, Macon, Cooper, and Marion. This species has not been listed in Missouri heretofore.

Helodrilus (Bimastus) zeteki Smith and Gittins, 1915

Length 10–12 cm. Somites 110–140. Color of anterior dorsal surface purple brown. Prostomium epilobic, 1/3–1/2. Setae closely paired. Clitellum on 27–37, and extends ventrally enough to include the ventral setae of 30–36. Tubercula pubertatis entirely lacking. First dorsal pore on 5/6; spermiducal pores on 15, slightly dorsal to b. Oviducal pores thickened (on 14) slightly dorsal to b. Septa 6/7–12/13 are slightly thickened, those of 13/14 more strongly so. There are about 60–64 partitions of the calciferous gland. Sperm sacs in 11 and 12. Spermathecae lacking.

It has been collected from the following states: Michigan, Indiana, Illinois, and Ohio; and from the following Missourian counties: Cape Girardeau, Jefferson, Osage, Marion, and Adair. This species has not been listed in Missouri heretofore.

Helodrilus (Bimastus) tenuis Eisen, 1874

Length, 4–8 cm. Somites 90–100. Color of the anterior dorsal surface rose red, rest of the body decided pale color. Prostomium epilobic 2/3. Setae widely paired. The clitellum is situated on somites 26–31. Tubercula pubertatis are indistinct and often lacking; when present usually on 29 and 30. The ventral setae of the sixteenth somite are borne on glandular papillae. First dorsal pore on 5/6. Spermiducal pores on 15, between b and c, situated on glandular elevations. Oviducal pores on somite 14, slightly dorsal to b. Septa are slightly thickened throughout. There are about 40 longitudinal partitions of the calciferous gland. Sperm sacs in 11 and 12. Spermathecae not fully developed.

Helodrilus tenuis is most abundantly found under decayed leaf mold and decayed timber. It has been collected in almost all parts of Europe, Asia, and South America. In North America it has been collected in Mexico, Alaska, Vancouver Island, Canada, California, New York, Maine, Indiana, Michigan, Colorado, Washington, Bering Island, Illinois, and Ohio.

This species was taken from a greenhouse in Cape Girardeau, Missouri. Later specimens were sent to the author from St. Louis, St. Charles and Marion counties and it is here listed in Missouri for the first time.

Octolasium lacteum Orley, 1881

Length, 5–16 cm. Somites 100–170. A few of the anterior somites are pink in color; posterior end is pale, while remainder of body, except clitellum, is blue-gray. Prostomium usually epilobic, 1/2–2/3; occasionally tanylobic. Setae widely paired. Clitellum on somites 30–35. Tubercula pubertatis on 31–34. First dorsal pore on 8/9, 9/10, or 10/11, in line with c and d. The septa 6/7–8/9 are slightly thickened, 9/10–13/14 are less thickened. There are about 45 longitudinal partitions of the calciferous gland. The calciferous gland communicates at its anterior end with the esophagus. The spermaries and the spermiducal funnels in 10 and 11, included in sperm vesicles. The spermaries are in 9–12; those of 9 and 10 being quite different in form and appearance from those of 11 and 12, which resemble those commonly found in the Lumbricidae. The sperm sacs of 9 and 10 are digitiform and each has a definite lumen extending through the greater part of the length.

This species is found in greater quantity under decayed leaf mold, compost heaps and logs, and in very rich soil. It is widely distributed in Europe and in various parts of the world. It has been collected in Illinois, California, Mexico, Indiana, Colorado, and Ohio. This species has not been listed in Missouri heretofore. It has been found in Cape Girardeau and Miller counties.

Genus **Diplocardia** H. Garman, 1888

Setae paired, absent from segment 19 on which the male pores are present; spermiducal pores on 18 and 20. Clitellum, 13–18. Two

pairs of prostate pores on both somites adjacent to the male pores. There are three pairs of sperm pouch pores, the posterior one on the 9th somite. Two muscular crops, mostly in the 5th and 6th, rarely in the 6th and 7th somites; separated, pouch-shaped calciferous glands. Esophageal pouches absent. Two pairs of free testicles and sperm funnels.

Diplocardia communis Garman, 1888

Length 18–30 cm. Number of somites 125–160. Color of the anterior dorsal surface pale flesh. Setae widely separated. Clitellum saddle-shaped, situated on somites 13–18 inclusive. Prostate pores on somites 18 and 20. Spermiducal pores on somite 19 and spermathecal pores in somites 6/7, 7/8 and 8/9. Sperm sacs in 9 and 12.

This species was the first genus to be described. It differs from the others in having a double dorsal blood vessel throughout the entire length of the body. (Smith (1918) states that this species is abundant in the prairie soils of Illinois. The author (1928) listed it in Ohio. It is widely distributed in Southeast Missouri in which it has been heretofore listed and has been taken from St. Louis, Cape Girardeau, Scott, Bollinger, Jefferson, Pike, Marion, Jackson, Lafayette, Boone, Macon, Adair and Franklin counties.

Diplocardia riparia Smith, 1895

Length, 20–27 cm. Somites 135–160. Color of the anterior dorsal surface dark brown, much darker than in *D. communis*. Setae in four pairs and wide apart. Clitellum saddle-shaped, on 12–18, of a dull copper color, usually slightly developed and sometimes absent. Prostate pores on somites 18 and 20. Spermiducal pores on somite 19, near anterior margin of somite. Two pairs of spermathecae, one pair in each somite of 18 and 19, with the external openings at the anterior margins of those somites and in line with the inner rows of setae. Sperm sacs in 9 and 12. Ovaries are in somite 13, and female pores in somites 14. Spermathecal pores on somite 7/8 and 8/9.

Smith (1915) states that this species is plentiful in the rich soil bottom land forests of Illinois. The author in 1928 listed it in Ohio and lists it now for the first time in Missouri from the following counties: Cape Girardeau, Perry, and St. Louis.

Diplocardia singularis Ude, 1895

Length, 5–10 cm. Number of somites, 90–120. Anterior dorsal surface flesh color. Clitellum on somites 13–18, inclusive, and of the cingulum type. Prostate pores on somites 18 and 20. Spermiducal pores on somite 19, and the spermathecal pores on somites 6/7, 7/8 and 8/9. Sperm sacs in 9 and 12.

Smith (1915) lists this species as being quite common in the upland regions of Illinois. The author, 1928, lists it in Ohio. This species has not been listed in Missouri heretofore. It has been collected in St. Charles, St. Louis, Cape Girardeau, Scott, and Ste. Genevieve counties.

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BOOK NOTICES

Children of Tomorrow

The principles and applications of eugenics are presented here in the form of questions and answers. The 371 questions and their well-thought-out answers cover rather completely the applications of eugenics to the population question, the individual, and the public. The presentation is objective in so far as it can be made so, and is free from objectionable propagarda and maudlin sentiment. The author, being a distinguished student of environment, as well as of heredity, approaches the problem with a broad viewpoint, unobscured by wishful thinking. The book can be well recommended to the general public.—L. H. S.

Tomorrow's Children, by Ellsworth Huntington. x+139 pp. New York, John Wiley and Sons, 1935. $1.25.

Learning Botany

This Workbook is designed for use in classroom discussions in the presence of materials. A majority of the thirty-three exercises are devoted to a consideration of the vegetative and reproductive phases of the typical flowering, seed-bearing plant. This is followed by a survey of the plant kingdom. The physiological aspect receives the greatest emphasis although all the major divisions of the field of Botany are adequately presented.

The book contains suggestions and questions regarding observations to be made. It provides aid to the recording of observed data in the form of graphs, blank charts and an extensive set of diagrams. Data needed in certain learning situations are supplied as well as problems calling for use of data in new situations. There are plans for summaries, and problems and questions leading to a recalling and weaving together of what has been accomplished. Subject matter is presented as a means to the teaching of the student rather than as an end in itself. The student is aware of his continuous mental development, and may acquire a true scientific attitude by becoming acquainted with and making use of the scientific method.—R. A. Dobbins.

Workbook in General Botany, by E. N. Transeau, H. C. Sampson, and L. H. Tiffany. v+160+73 pp. Looseleaf; lithographed by Edwards Brothers, Inc., Ann Arbor, Michigan. 1935. $1.75.

Termites and Termite Control

The first edition of this outstanding report of "The Termite Investigations Committee" was published in January, 1934. Since then the authors of the various chapters have continued their researches and have reported their results in the second edition, revised, which has been recently published. No change has been made in chapter 46, which contains the general recommendations for the control of termite damage. The major additions are (1) in Chapter 2, a paragraph on the relation of moisture to the production of arsine from wood preservatives containing arsenic; (2) in chapter 4, additional experimental data bearing on the sensitiveness to moisture of the Pacific Coast species of termites; (3) in chapter 9, experimental evidence that termites are dependent upon fungi for the nitrogenous elements of their diet to such an extent that in the absence of fungi their normal growth is retarded; (4) in chapter 24, an experimental investigation of caste differentiation in termite communities; (5) in chapter 34, changes regarding Bruce Preservative, Halowax, and Wolman Salts; (6) in chapter 36, substitution of the 5th Progress Report of the International Termite Exposure Test for the 4th Progress Report; (7) in chapter 41, a statement of the essential features of the Standard Biological Test; also, some Standard Biological Tests on two wallboards, and an experimental test of the toxicity and penetration throughout the test block of refined creosote in a solvent; and (8) in the added chapter, 57, a discussion of the association of termites with arsine-producing fungi. An excellent subject index has been added, which was one criticism of the first edition.

The writers are indeed to be congratulated on this second edition. It is a most complete report and serves as a noteworthy example of what can be accomplished when scientists, engineers, and corporations co-operate in solving such problems. Every contractor, architect, and engineer should possess a copy. As a scientific reference on the subject, it is invaluable for entomologists and teachers of biology.—R. H. DAVIDSON.

Termites and Termite Control, by Charles A. Kofoid et al. 795 pages, 182 figures. Second Edition, Revised. Berkeley, University of California Press, 1936. $5.00.

Procedure in Taxonomy

This little book is the result of a symposium on taxonomy by graduate students and professors at Stanford University. It was prepared "for the purpose of supplying the student as well as the professional systematist with (1) a clear-cut and comprehensive statement of the principles of taxonomy; (2) the International Rules of Zoological Nomenclature; (3) Summaries of Opinions Rendered to the present date; (4) a complete index—the only index of the Rules and Summaries ever published."

The original material in the book is very brief, covering only 25 pages. The chapter headings are: Introduction, Systematic Categories, Types, Descriptions of New Species, Specific Names, Synonymy, Storage of Type Material, and Latin Terms and Abbreviations. The chapters on Types, Synonymy, and Latin Terms and Abbreviations are particularly valuable. The chapter on Synonymy is concerned with methods of listing synonymy, and contains suggestions which, if followed by all taxonomists, would eliminate a great deal of confusion. The chapter on Descriptions of New Species contains very little of value to the zoologist; the examples given are from the field of paleontology. The very important matter of drawings is barely mentioned. The chapter on Specific Names contains some good suggestions for the selection of new names, but lacks a discussion of the Law of Priority as it applies to the use of specific names. A subject completely overlooked in this book is the matter of constructing analytical keys, which is certainly an important phase of taxonomic procedure.

The brief, concise discussion, as far as it goes, and the copy of the Rules and Opinions, make this book a handy one for any paleontologist or zoologist venturing into the field of taxonomy.—D. J. BORROR.

Procedure in Taxonomy, Including a Reprint of the International Rules of Zoological Nomenclature with Summaries of Opinions Rendered to the Present Date, by Edward T. Schenk and John H. McMasters. vii+72 pages. Stanford University, California, Stanford University Press, 1936. $2.00.

Atoms

This book, which originally appeared in German under the title "Moderne Physik," is an excellent exposition of the theoretical development of modern physics. The book is written in a style which makes it attractive reading for the student not too far advanced in his graduate work. A delightful feature is the set of appendices at the end of the book where rigorous proofs to many of the hypotheses stated are given. The English edition has been thoroughly modernized and brought up to date with the developments of recent years.—H. H. NIELSEN.

Atomic Physics, by Max Born. xii+352 pp. New York, G. E. Stechert and Co., 1936.

Our Enemy the Termite

In order to properly cope with the termite or so-called "white ant," the public should be better informed on this subject. One means of obtaining a better understanding of this very interesting group of insects is by reading this book written by Dr. Snyder. He presents in readable style, a very interesting but concise scientific discussion of all phases of the termite problem.

The first six chapters discuss the place of termites among insects; the different species of termites; their life history and the caste system; their physiology and behavior; their food habits and guests of the termite colony. The four remaining chapters discuss the damage done by termites and methods of control. Practical suggestions are given for building termite-proof houses and for saving structures already infested. Various methods of control now being used are discussed and fraudulent ones exposed.

An appendix is included which contains recommendations for city building codes, for insuring protection against termites and decay, a model tally sheet for recording termite damage by building inspectors, and specifications for an agreement between the house owner and a contractor undertaking to remedy termite damage to buildings.

A table of contents, an index, and a glossary of technical terms are included. Many illustrations aid in the presentation of material. Large easily read type on good quality paper, combined with simple presentation of subject matter make this book especially valuable to the home-owner and contractor.

R. H. DAVIDSON.

Our Enemy the Termite, by T. E. Snyder. 196 pp., 56 figs. Ithaca, The Comstock Publishing Co., 1935. Price, $3.00.

Valence

This recent book by Kronig which has appeared in the Cambridge Series of Physical Chemistry is a valuable asset to the library of any physicist or chemist. The contents, which are chiefly devoted to a discussion of the band spectra of diatomic and polyatomic molecules and their bearing upon the problems of molecular structure and chemical binding, are comprehensive, yet presented in a manner such that the book may be read by a student of chemistry or physics in his early graduate career. In a preliminary course in molecular theory where the more intimate problems are not dealt with, the book would appear to be a very suitable text.—H. H. NIELSEN.

The Optical Basis of the Theory of Valence, by R. deL. Kronig. viii+246 pp. Cambridge, at the University Press; New York, the Macmillan Co., 1935. $4.50.

Serological Reactions

This monograph, from the pen of the distinguished Nobel Prize winner, Karl Landsteiner, brings together under one cover the results of a long series of serological experiments by many workers, including the author and his associates. Critical problems involving the antigen-antibody reactions are surveyed, and various hypotheses are compared and evaluated. The antigenic properties of proteins, carbohydrates, lipoids and artificial conjugated substances are thoroughly discussed. Recent work on the chemistry of cell antigens is presented. Particularly interesting and valuable are the chapters on the specificity of cell anti-

gens, and the specificity of antibodies. Comprehensive bibliographies are included at the ends of the various chapters, although the arrangement of the references is not conducive to their most efficient use.—L. H. S.

The Specificity of Serological Reactions, by Karl Landsteiner, M. D. vii+178 pp. Springfield, Illinois, Charles C. Thomas, 1936. $4.00.

Quantum Mechanics

This book is an attempt to replace the physical models, of which the experimental physicist was earlier so fond, with the quantum mechanics. Wherever it is possible graphical methods are employed. Such problems as the formation of molecules, valence bonds and electrons in crystals receive especial attention, while the last chapter is devoted to the topic of perturbation theory as applied to physical problems and to a discussion of the description of physical events. The book can be very sincerely recommended to the student of physics and chemistry.

H. H. NIELSEN.

Elementary Quantum Mechanics, by R. W. Gurney. vii+159 pp. Cambridge, at the University Press; New York, the Macmillan Co., 1934. $2.35.

The Meaning of Chemistry

The sixth edition of this fine work has been revised by Glasstone, and is a worthy successor to the previous editions. The volume is an extraordinarily well written introduction to the subject of chemistry and chemical research. It begins with a discussion of such simple things as the nature and purpose of laboratories, the description and use of apparatus, and the general meaning of chemistry. For the non-technical reader (for whom the book was written) this is especially worth while, since a knowledge of such things is mistakenly taken for granted in most chemistry books written for the layman. One by one the underlying principles of chemistry are clearly developed, until the reader is prepared to enter the field of practical applications. These are presented in most readable style. The last section deals especially with organic chemistry. New material in this edition includes up-to-date discussions of valency, atomic structure, transmutation and disintegration of elements, artificial radioactivity, heavy hydrogen, synthetic rubber, artificial plastics, vitamins, hormones, and nitrogen fixation. The book is most highly recommended to those interested in acquiring an understanding of the work of the chemist.—L. H. S.

Chemical Discovery and Invention in the Twentieth Century, by Sir William A. Tilden. Sixth edition, revised by S. Glasstone. xvi+492 pp. New York, E. P. Dutton & Co., 1936. $4.00.

Protoplasm

Under this title Dr. Seifriz has written a very readable book for students of biology, medicine, and related fields. The discussion considerably exceeds the bounds indicated by the title and the book would serve as a satisfactory introduction to the subject of general physiology. An adequate background of physicochemical concepts and principles is presented before the author proceeds to a discussion of the biological aspects of the subject. Both the dull finality of scientific dogmatism and the inconclusiveness of too encyclopedic presentation have been skillfully avoided. A few mis-statements will be noted by a careful reader, but on the whole the book is commendably free from factual errors. The reviewer's principal criticism is that the last few chapters do not seem to maintain quite the high standard set by most of the book. A fairly extensive selected bibliography, classified according to chapter headings, is appended to the discussion.—B. S. MEYER.

Protoplasm, by William Seifriz. 584 pp. New York, McGraw-Hill Book Company, 1936. $6.00.

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STUDIES WITH ARTIFICIAL FEVER IN EXPERIMENTAL TUBERCULOSIS[1]

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During the past three years studies of the effects of artificial fever on the cellular equilibria in experimental animals have been conducted in the laboratories of the Department of Medical and Surgical Research, Ohio State University, with a high frequency, short wave radio-therm constructed and serviced by Professors Dreese and Byrne of the Department of Electrical Engineering.

That artificially induced fever effects beneficially certain diseased states in man has been rather clearly and definitely demonstrated in recent years. The present task of those interested in this approach toward a better mobilization of the immune forces of the body is to reveal the mechanism or mechanisms by which this desired end is accomplished and to differentiate those conditions in which such therapy may be contraindicated.

There are three avenues by which fever might prove beneficial in combatting infectious disease: (1) by the actual destruction or attenuation of the infecting agent, the thermal death point for the pathogenic bacteria being lower than that for the host cells; (2) by enhancing the development of humoral antibodies; or (3) by stimulating a more effective mobilization of the phagocytic cells of the blood and tissues; or, of course, any combination of these three effects may be hypothesized.

Among those infections mentioned as possibly susceptible to the beneficial results of hyperpyrexia has been tuberculosis. Duncan and Mariette (1) reported the attenuation in vitro of acid fast strains of organisms at human fever temperatures.

[1]Read before the Ohio Academy of Science, April 18, 1935.

Professor W. A. Sterin, of the Department of Bacteriology, however, who has carried on similar studies in co-operation with our group has been unable to demonstrate either lethal or virulence altering effects of fever temperatures upon any of the acid fast group of pathogenic organisms studied under in vitro conditions.

The present report deals with certain observations made in rabbits experimentally infected with virulent tubercle bacilli and subjected to repeated "feverings." Two kilogram rabbits were selected and inoculated with a thirty-day culture of Bovine B-1, undissociated acid fast organisms. Baseline observations for a period of at least two weeks were made on all animals prior to inoculation. Total white cells, supravital differentials, total red cells, and hemoglobin were determined and weights and temperatures were recorded six times during this period. Chest X-rays were made of all animals, and the animals selected for fevering were subjected to a preliminary heating in the radiotherm before inoculation.

A single fevering, in this experiment, consisted of placing one animal at a time, in the radiotherm, and exposing it to a radio frequency of four thermo-ameters, 25 meter wave length, 12,000,000 oscillations per second, for approximately twenty minutes, during which period the rectal temperature rose from 102° to 107°–108° F. This temperature was then maintained by a continuous flow of from 1–2 thermo-ameters, for a period of one hour. At the end of this time the animal was removed from the set and its temperature allowed to return to normal under room conditions. Temperature changes in the animal were followed at intervals of ten minutes while in the radiotherm and every thirty minutes thereafter until the temperature had returned to normal. Blood counts and weights were taken before the rabbit was placed in the set, at the end of one hour of fevering and again when the temperature had returned to normal. The animals selected for fevering were subjected to this elevation of temperature twice a week until death intervened or the observations were terminated. X-rays of the chests of all animals were taken every twenty days. Blood, temperature, and weight changes were followed throughout the experiment, on all animals, at intervals comparable to those established during the base line period.

In the first experiment, fourteen animals were selected for observation. Seven of this group were injected with 0.1 milli-

gram of the Bovine culture, intravenously. Six others received 0.2 milligrams intratracheally. One animal was not inoculated, and served as a normal fever control.

Four animals of the first group and three of the second group were selected for fevering. Fever therapy was begun twenty days after the inoculations. The chest X-rays, taken at this time, showed definite pulmonary lesions. The blood picture also was typical of tuberculous disease (2, 3). The animals injected intravenously survived only one or at most two feverings; the disease process was so acute and the pulmonary congestion so great, that the vital capacities in these rabbits were insufficient to support the added cardiac and respiratory demand during fever treatment. Tuberculous controls inoculated at the same time but not subjected to fevering were killed at the time the others died. At autopsy, all animals showed gross lesions in practically all organs of the body. Gross hemorrhages were found in all of the fevered animals and in but one of the controls. In this group, the amount of the fever therapy was of necessity so limited by the acuteness of the tuberculous process which developed, that it was impossible to draw any conclusions. There is no question but that animals in such a serious and far advanced condition cannot survive an elevation of temperature to the degree mentioned (107–108° F.).

Of the group injected intratracheally, one animal survived three feverings, another eight, and the third nine. The non-fevered controls all outlived the fevered group and were killed by air embolism for comparative autopsy study.

The blood studies showed a definite reversal of the M–L ratio (4, 5) in the fevered animals, in contrast to the non-fevered controls. At postmortem, the dissemination of organisms appeared greater in the fevered group, as indicated by the extent of gross lesions. All fevered animals showed definite gross hemorrhages particularly in the thymus. The normal animal was fevered nine times, and showed no significant cellular changes in the peripheral blood. The weight and temperature of the normal animal remained within normal limits. This animal was not killed at this time but was fevered repeatedly throughout the subsequent experiment as a control.

The above observations indicated the necessity for further study on animals with a less fulminant tuberculosis.

For the second experiment, six animals were selected. Baseline observations were made as indicated above. All of

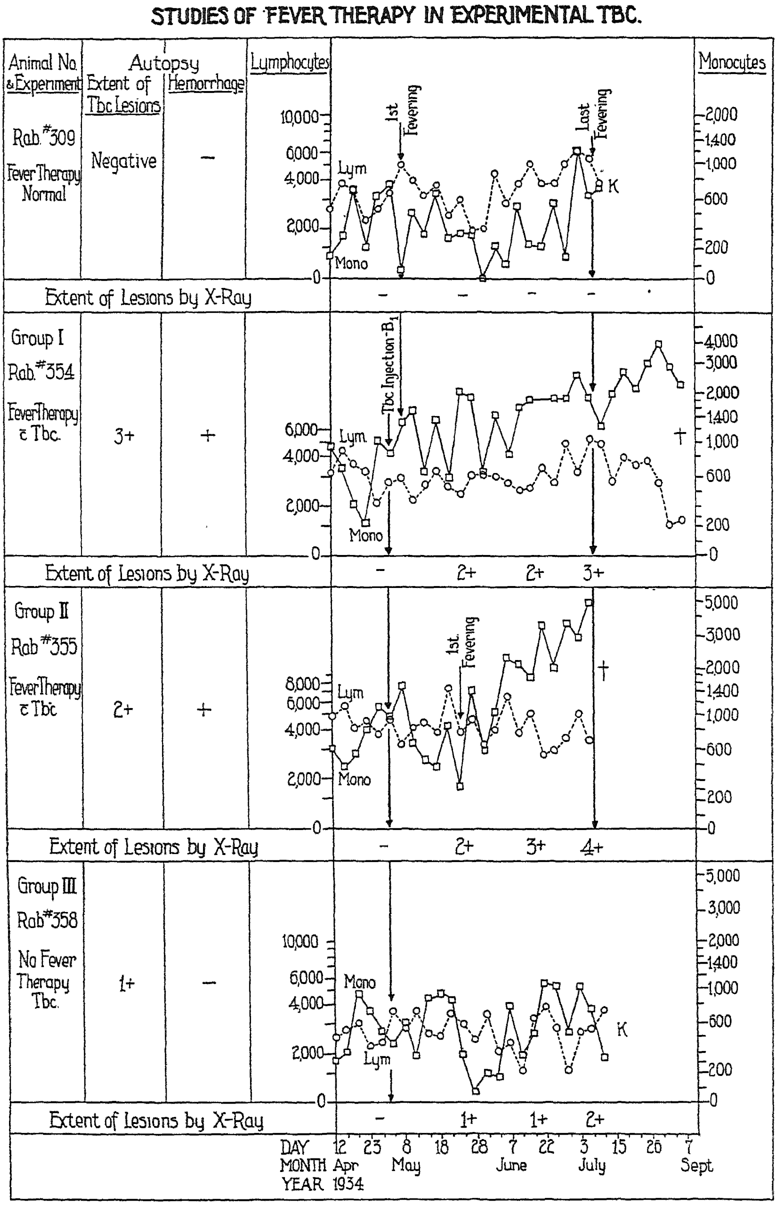
STUDIES OF FEVER THERAPY IN EXPERIMENTAL TBC.
Animal No. & Experiment
Autopsy
Extent of Tbc Lesions
Hemorrhage
Lymphocytes
Monocytes
Rab. #309
Fever Therapy Normal
Negative
–
1st Fevering
Last Fevering
Lym
Mono
K
Extent of Lesions by X-Ray
Group I
Rab. #354
Fever Therapy c̄ Tbc.
3+
+
Tbc Injection-B1
2+
3+
Group II
Rab #355
Fever Therapy c̄ Tbc
4+
Group III
Rab #358
No Fever Therapy Tbc.
1+
DAY 12 23 8 18 28 7 22 3 15 26 7
MONTH Apr May June July Sept
YEAR 1934

Chart I

these animals were inoculated intratracheally with one-fiftieth milligram of the Bovine B-1 Culture. Two of this group were fevered, beginning three days after inoculation; two others were started twenty days later, and a third group of two was held as tuberculous controls without artificial fever. The normal animal was fevered with this group. Fever was induced two times a week. The animals in Group I were fevered a total of seventeen times. The animals in Group II started twenty days after injection and were fevered twelve times. The animals in Group III received no fever therapy. The normal control was fevered seventeen times in this experiment, a total of twenty-six times during the two experiments.

The chest X-rays were negative on all of the animals before inoculations were made. The extent of the lesions after twenty days was estimated two plus in Groups I and II, and one plus in Group III. Forty days after inoculation, Group I manifested evidence of two plus lesions, Group II three plus lesions, and Group III only one plus. Sixty days after the inoculation, Group I showed three plus lesions, Group II four plus lesions and Group III two plus lesions. X-rays on the normal control were uniformly negative.

One animal from each group, and the normal control were killed at the end of this period of nine weeks. At autopsy, the dissemination of organisms was estimated by the extent and the gross distribution of tuberculous lesions in various organs. The first group showed a three plus dissemination. Group II showed a two plus, and Group III only one plus; that is, tubercles were found only in the lung. Pin point hemorrhages were observed in the thymus glands of the animals in Groups I and II. There were no remarkable temperature or weight changes during this period, in any of the animals. (Slight weight decrease in three out of four fevered animals.) The changes in monocytes and lymphocytes, however, were striking. Chart I shows the relative and absolute changes in the M/L ratio, as found during the course of the experiment in one animal from each of the different groups. With the first induction of artificial fever—regardless of the duration of the disease—a sharp reversal of the M/L ratio in the circulating blood was precipitated. It has been shown (2) and amply confirmed that the M/L ratio in the blood is an accurate index of new tubercle formation in the tissues in tuberculous disease. A persistently rising monocyte curve and a steadily falling

lymphocyte count is of bad prognostic significance. Following the marked vasodilitation and hyperventilation induced by fever therapy an increased dissemination of the disease occurred, reflected most sensitively and accurately by these blood cell changes. The figures from the fevered animals charted on the graphs were taken from the blood counts obtained just before each fevering.

The blood changes occurring in the animals in Groups I and II, kept for longevity studies, continued to reflect an acute tuberculous course, terminating in death, approximately two months after the others were killed. The tuberculous non-fevered control animal survived a longer time with much less change in the blood picture. The degree of dissemination of the disease as indicated by gross lesions, was in the same proportion, in these animals, as in the animals that were killed previously. The microscopic findings were consistent with the gross observations made at the time of autopsy.

The acute blood changes which occurred during the actual fevering were especially interesting from the standpoint of the monocytes and lymphocytes. There was a marked initial depression of circulating cells, both in the tuberculous and in the normal animals during fever. This was followed by a decided monocytic leucocytosis in the tuberculous rabbits only, as the temperature returned to normal. This reaction may be compared to that reported by Geiger (6) upon the injection of colon bacilli into tuberculous as contrasted with normal guinea pigs. The reaction to artificially induced fever, like that to colon bacilli, reveals an excessive tissue storage of monocytes in tuberculous animals, the result of the specific tuberculo-lipoid effect and the tubercle formation (4).

CONCLUSIONS

1. Rabbits with primary pulmonary tuberculosis cannot long survive an artificially induced elevation of temperature to 107°–108° F.

2. There is more rapid and extensive lung involvement as shown by X-ray and post-mortem studies in animals that are fevered than in those that are not fevered during the course of the disease.

3. There is a definite increase in dissemination of organisms in fevered rabbits as evidenced by a prompt reversal of the M/L

index in the blood, by a wider distribution of gross tubercles and by the greater tendency to hemorrhage.

4. Similar elevations of temperatures at repeated intervals in a normal non-tuberculous animal produced no significant alteration in the cellular relationships in the blood or tissues.

5. The blood changes and the physical findings in these experiments suggest a definitely harmful effect of fever therapy in rabbits with primary tuberculosis of bovine type.

6. On the basis of these studies, no human patient with tuberculous disease has knowingly been treated with artificial fever therapy by our group.

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New England Geology

Almost twenty years ago the original manuscript of this work was prepared for publication. Various causes contributed to the long delay in publication, during which time the senior author died. Most of the field work was completed in 1914–1915. The work is divided into three parts. The first considers the region as a whole and develops a correlation with the glacial geology of Long Island as worked out by M. L. Fuller (U. S. Geol. Survey Professional Paper 82, 1914). Four glacial stages are described tentatively correlating with the four glacial advances in the Middle West. This is not in keeping with the three generally recognized stages in the New York State Area. Needless to say, most of the work deals with the Pleistocene, as Pre-Pleistocene exposures are few and far between in the region. The Pre-Cretaceous basement is mentioned but as it does not really enter into the geology it is not discussed at length.

Part II is devoted to "Geology of Particular Areas." The general plan of procedure in these chapters is the geography, the geology and a bibliography of the area. Here are taken up Nantucket and adjacent islands; Martha's Vineyard, No Man's Land, and Block Island.

Part III is devoted to the geology of Cape Cod and the Elizabeth Islands.

The paleontology and paleobotany are handled by others than the two authors. Twenty-three text figures and 38 plates greatly increase the value of this work. Six of the plates are geologic maps showing exposures as they were in 1914–1915, allowing future investigators to visit their localities and exposures. Everyone studying the Pleistocene must of necessity become familiar with this excellent piece of work.—WILLARD BERRY.

Geography and Geology of the Region Including Cape Cod, the Elizabeth Islands, Nantucket, Martha's Vineyard, No Man's Land, and Block Island, by J. B. Woodsworth and Edward Wigglesworth. xvi+322 pp. Cambridge, Memoirs Museum of Comparative Zoology, Harvard College, Vol. 52, 1934.

THE BLACK HAND FORMATION IN NORTH CENTRAL OHIO

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The Mississippian series in central Ohio consists of a series of alternating sandstones and shales, the thin vein of the Maxville limestone being absent. These are more generally known as the Waverly. The epeiric basin in which they were deposited was unquestionably subject to variation in water currents and consequently a fine grained sandstone or a free-stone and a shale may be found in the same facies at no great distance apart horizontally. On this account the correlation of the various subdivisions into which the Mississippian series in this area may be divided is difficult.

Between the Berea grit, a persistent sandstone which is near the base of the Mississippian, and the Pennsylvanian, another sandstone which has been given the name of the Black Hand from the narrows of the Licking river, east of Newark, where there is an exposure two miles long in an east-west direction, persists from the Ohio River northward to some distance north of Mansfield. This sandstone has been traced from the Ohio river to the Licking river, in southern Ohio by Hyde.[1] The horizon of this sand is known to the oil driller as the Big Injun and the sandstone is found in most well records in eastern and southeastern Ohio.

North of Newark, where the surface has not only been subject to the erosion of two ice sheets, but is covered with glacial till to varying depths, the present outcrops are fewer and the former extent of this sandstone must be determined with the aid of well records, both water and oil.

The Black Hand is a coarse, sharp sandstone with varying binders. In some localities the sandstone is gray, comparatively free from iron, and easily crushed into a good grade of glass-sand; in other localities the color is a light buff and is quarried for building stone. The general characteristic is its coarseness, sharpness and the frequent presence at various levels of a quartz pebble conglomerate, the pebbles varying

[1]Jour. Geol., Vol. XXIII, p. 665 seq.

in different localities from a maximum of one to one-quarter inch in diameter. The outcrops of the sandstone in this area vary from 20 to 70 feet in thickness, though some well records indicate a greater local thickness.

Another characteristic of the Black Hand, in which fossils have not been found, is the presence from five to thirty feet above its top, of a shale and fine sandstone strata that is fossiliferous. This is always found except in localities where erosion has removed the higher strata.

Fig. 1 is a map of the area from Licking to Richland and Ashland counties, on which are marked the outcrops, quarries and some well records of the Black Hand sandstone. The various locations are numbered on the map and the elevations of the top of the sandstone above sea level indicated. These outcrops are briefly described:

1. Black Hand Narrows of Licking river, Hanover twp., Licking county; forty foot exposure, ten feet containing quartz pebbles.
2. Pennsylvania railroad cut, one mile east of Hanover village, Hanover twp., Licking county; twenty-five foot section.
3. Rain Rock, Eden twp., Licking county. The Black Hand outcrops also on Rocky fork, west of Rain Rock.
4. Abandoned stone quarry on top of hill, one mile south of Utica, Washington twp., Licking county; twenty-five foot section exposed.
5. Along bank of Wakatomika creek, sec. 24, Jackson twp., Knox county; thirty foot section exposed, one-quarter to one inch conglomerate about the middle.
6. Rocky Hollow and Millwood Sand Co. quarry, along Kokosing river, two miles southeast of Millwood, Union and Butler twps., Knox county; 40 foot section exposed, quartz pebbles in three feet of section, western part of outcrop.
7. Water wells in glacial till, near Polk school and Weaver school, Liberty twp., Knox county; the drilling records show 30 and 130 feet, respectively, to rock, which places top of sandstone in both wells at 1,260 feet and indicates that strata above Black Hand had been eroded prior to or by glaciation.
8. Keller's Rock, southwestern part sec. 8, Pike twp., Knox county, along Little Schenck creek; 20-foot exposure, five feet of which contain one-quarter inch quartz pebbles.
9. Quarry, north of state road 97, sec. 13, Jefferson twp., Richland county; fifteen feet sandstone exposed.
10. Clear Fork, Mohican river, sec. 7, Hanover twp., Ashland county; Lyons Falls is an overhanging sandstone ledge fifty feet high, with concave under surface, similar to Ash Cave, Hocking county; sixty feet exposed, one-half inch quartz conglomerate near bottom. These exposures of the Black Hand are in the upper part of Mohican State Park.

county the interval is about 2,250 feet, the distance being about 22 miles.

If the facies from the top of the Black Hand to the Berea

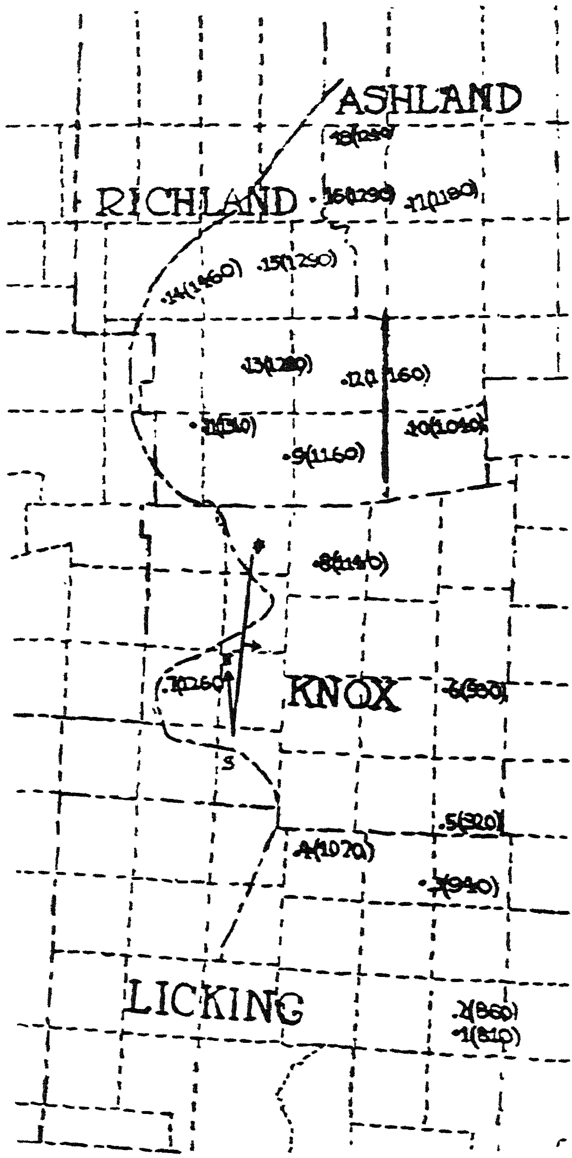

FIG. 1. Axis of the Dip of the Black Hand. Western Extent of the Black Hand.

11. Water well, west sec. 1, Perry twp., Richland county; elevation of well head 1,320 feet, 11 feet to sandstone, rock more than 160 feet thick.
12. Along Switzer creek, sec. 34, Monroe twp., Richland county; 25 feet exposed, one inch quartz pebbles at top, one-eighth inch conglomerate through entire section.
13. Opossum run, east sec. 16, Washington twp., Richland county; forty feet exposed, twenty-foot waterfall, concave "cave" behind fall.
14. Quarter mile northeast of elevation 1,500, sec. 34, Springfield twp., Richland county; coarse grey sandstone with quartz pebbles, fifteen feet exposed. This is the second highest area in Ohio.
15. Old stone quarries, sec. 15, Madison twp., Richland county, north of Mansfield, near state reformatory; sixty-foot section, no conglomerate.
16. Old stone quarry, north of Pavonia school, sec. 31, Weller twp., Richland county; fifty feet exposed quartz conglomerate in irregular vein, six inches thick, 30 to 40 feet from top.
17. Water well, northwest sec. 32, Montgomery twp., Ashland county; well drilled into soft grey sandstone.
18. Northwest sec. 16, Milton twp., Ashland county; sandstone within ten feet of surface of entire knob, thickness of sandstone eighty to ninety feet, water beneath rock.

A correlation of these sections and well records, as shown in Fig. 1, indicates that the Black Hand sandstone in this area is variable in thickness and that the general dip of the top of the sandstone is uniform and approximately nineteen feet to the mile in a direction south of east. The top of the Black Hand is more uniform as measured stratigraphically and the variation in thickness seems to occur at the base of the formation.

From well records in central Liberty township, Knox county, the top of the Black Hand is 1,260 feet above sea level, and the top of the Berea grit 600 feet; in sec. 15, Perry township, Coshocton county, the top of the Big Injun sand is 860 feet and that of the Berea grit 190 feet above sea level. In the twenty-two mile distance across Knox county from west to east the dip of the Black Hand and of the Berea is about nineteen feet to the mile for both and the interval between them is uniformly about 650 feet. Other well records confirm this uniform thickness of the lower Waverly strata in Knox county. In contrast the thickening of the strata between the Berea grit and the Clinton sand in an east-west section across Knox county is pronounced. In western Knox county the interval is slightly more than 1,600 feet and in eastern Knox

grit is designated the Cuyahogan and the facies above the Black Hand the Logan, the thickness of the Cuyahogan is uniform in the area under consideration. Such is not the case with the section of the Logan. In Pike township, Knox county, the Harrison ore, or basal conglomerate, of the Pennsylvanian is found on the surface a mile east and southeast of North Liberty, at a level 180 feet above the Black Hand, at Keller's Rock. On the Wakatomika creek, in sec. 24, Jackson township, Knox county, the basal conglomerate is 110 feet above the top of the Black Hand and 110 feet below the No. 2 or Quakertown coal. The lack of uniformity in thickness of the Logan is general in Knox county.

That the western extent of the Black Hand formed an escarpment prior to glaciation is definitely indicated by the variation in hilltop levels to the west and northwest of Knox county. A study of the topographic sheets shows that the uniform westerly rise of the resistant Black Hand causes the elevated area extending from the highlands around Olivesburg, Weller township, through Richland county to the west of Mansfield, where in sec. 34, Springfield township, the second highest area in Ohio has an elevation of over 1,500 feet, and a bedrock covering of less than 20 feet; thence southerly including Liberty township, Knox county, where the Black Hand is covered with glacial till to a depth varying up to 130 feet. The western extent of the Black Hand is indicated by the irregular line on Fig. 1. Several of the higher areas along the western limit of the Black Hand are outliers due to stream channels having been cut through the sandstone prior to glaciation. Also, in Liberty township, west of Mt. Vernon, the highest area in Knox county is covered with glacial till above the Black Hand, while in Pike township, northeast of Mt. Vernon, over 100 feet of Logan thin sandstones and shales overlie the Black Hand. The persistence, resistance to erosion and the stratigraphic plane of the top of the Black Hand sandstone, as described above, furnishes a definite horizon for the division of the Cuyahogan from the Logan.

In the exposure of the Black Hand, near Millwood, Knox county, where the Kokosing river has cut through the sandstone and weathered vertical sections along the stream show surface erosion indicating possible bedding planes with an inclination of from 15 to 20 degrees to the east.[2] Excavations

[2]Geol. Survey of Ohio, vol. III (1878) p. 337.

in the Millwood sand quarry show no bedding planes with a greater dip than the normal 19 feet to the mile. The cause of these possible bedding planes which incline such an angle may be due to a sloping basin or delta in which the sandstone was originally deposited. While there are indications in eastern Knox county of slight waves of minor anticlines and synclines with crests at intervals of about four miles, as determined by the occurrence of natural gas in the Berea, neither the location

FIG. 2. The face of the sandstone at Rocky Hollow.

of these crests nor the amplitude of the waves would account for the sloping bedding planes of the Rocky Hollow sandstone walls. Fig 2 is an illustration of the face of the sandstone at Rocky Hollow.

The fossils found in the shale-sandstone strata above the Black Hand are:

Crenipecten winchelli.
Conularia sp.
Syringothyris texta.
Camarotoechia sageriana (or sp.).
Productus sp.
Crinid stems.

ADDITIONS TO THE OHIO LIST OF ROBBER FLIES. III. (DIPTERA: ASILIDAE)

STANLEY W. BROMLEY

In my second list of additions to the Ohio Asilid fauna (OHIO JOURNAL OF SCIENCE, Vol. XXXIV, No. 3, May, 1934, pp. 163–164) the total number for the state was brought to 74 species. During 1934, the following species, collected for the first time in Ohio, were added:

75. *Leptogaster loewii* Banks. Amherst, Lorain County, July, 1934. Three specimens, collected by H. J. Reinhard.
76. *Taracticus octopunctatus* Say. Laurel Township, Hocking County, June 24, 1934. Collected by C. F. Walker and Edward S. Thomas. Five specimens, Bern Township, Fairfield County, July 25–August 1, 1934, collected by Robert Goslin. One had been captured and was being eaten by a jumping spider.
77. *Bombomima affinis* Macquart. Rock Run, Jackson County, September 2, 1934 (one female). Collected by John S. Thomas.

The two latter species were included in my original hypothetical list of species which should occur in Ohio, but it was not until 1934 that they were actually collected. Other interesting finds were two specimens of *Proctacanthus milbertii* Macquart, taken by Mr. H. J. Reinhard at Amherst, in July, and a male of *Proctacanthus hinei* Bromley, collected at Bay Point, Ottawa County, July 8, 1934, by Edward S. Thomas. The latter species is a beautiful large orange-red form that occurs in the sand dune areas about the Great Lakes. Dr. R. C. Osburn collected several at Pelee Point, Ontario, Canada, July 20–30, one of which (a female) had captured and killed a large female specimen of the Carpenter bee, *Xylocopa virginica* Drury.

Most interesting of all was the taking of another specimen of the very rare *Dasylechia atrox* Williston, making the fifth specimen of this species to be found in Ohio. Strange as it may seem, a male of *D. atrox* was found on the steps of the Botany and Zoology Building of the Ohio State University on July 24, 1934, by Mr. C. Vennard. It was presented by the collector to the University Collection which is housed in that building. This widely distributed species, recorded from New York, New Jersey, Pennsylvania, Ohio, Michigan, Kansas, and Utah, is one of the rarest of North American Diptera. Even now there are scarcely more than a dozen specimens in all the collections in the world. Of the five specimens collected in Ohio, one is in the collection of the late Charles Dury, of

Cincinnati, one in the Ohio State University Collection, and three are at the Ohio State Museum. Of the specimens at the State Museum, one was in the James S. Hine Collection, and two were collected by Mr. Charles F. Walker in 1933.

THE FOOD AND BREEDING HABITS OF THE RACCOON

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The awakening interest in fur-bearing animals shown by conservation circles is in keeping with the importance of this group. Attempts to increase the supply and give better protection to those which are becoming less abundant are laudable and deserving of praise. Unfortunately, the sporadic interest exhibited by various game commissions, and their often ill-advised efforts to increase the natural supply, result in dismal failure. This may be attributed, in large measure, to the lack of information available on the habits of the animal in question. Furthermore, conscientious efforts to restore a waning population of any fur-bearer is met with opposition by many hunters, who make the biased, and often unfounded claim that all mammals are detrimental to the well-being of game birds.

With federal attention being directed to the economics of sub-marginal lands, and policies being drawn for future management of the wild life of these areas, attention might well be given to the importance of increasing the fur supply. The intent of this paper is to introduce certain aspects of the life history of the raccoon, *Procyon lotor lotor*, which have hitherto been neglected. More investigations into the habits of our fur-bearers are urgently needed. Such information should be placed at the disposal of the various game commissions, so they might utilize these data in constructing wise and efficient laws.

FOOD OF THE RACCOON

General works of natural history list the raccoon as being omnivorous; fish, frogs, crayfish, insects, small mammals, fruits and berries, nuts and grains, being the more staple foods.

Dearborn (1932) has reported on about 500 raccoon feces examined from Michigan. The most important item, crayfish,

constituted 58.99 per cent of the food, while the remainder was distributed among the following items in the order of their volume: grain, 20.20; fruits, 12.22; insects, 5.34; mammals, 1.11; molluscs, .91; fish, .70; birds, .43; eggs, .05; reptiles, .04; and amphibians, .01. This, ostensibly, represents in large part the summer food of the raccoon and is not a fair index to the average diet throughout the year.

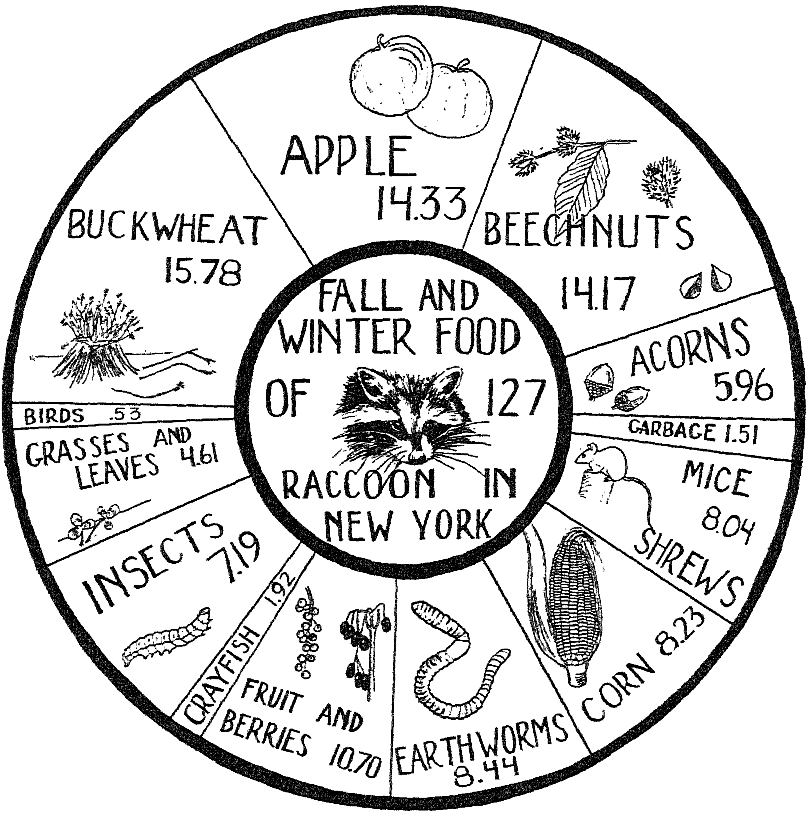


CHART I.

Whitney (1931) has examined large numbers of Connecticut raccoons during the hunting season (October 21 to December 31). Corn, oats, nuts, wild cherries, apples, pears, grapes, crickets, white grubs and trout are the only items he found, with a few exceptions.

From 1927 to 1934 the writer has collected the visceral tracts of 130 raccoons from hunters. These were shot in widely

separated areas of New York. The specimens were collected from November 16th to January 22nd. Distribution by months was as follows: November, 55; December, 51; and January, 24. Of those examined, three were empty.

In the region from which the specimens were collected zero weather is not uncommon during December and January. The occasional thaws and rains of these months, with temperatures of 38 degrees Fahr. to 40 degrees Fahr. may extend over a two or three day period. Raccoon take advantage of these mild spells to venture from the den tree and seek food. Few are hunted at this season. Probably 90 per cent of all the raccoons taken in the state are caught during the first four weeks of the season, which extends, in Western New York, from November 10th to January 20th.

Reference to the diagram will give an index to the types of food eaten by these animals during the late fall and winter. The food is computed as percentage by bulk.

In a study of a wild animal's food, one must remember that the bulkiest food is not necessarily the most important. Often a single item will contribute relatively little to the actual amount eaten, but may, because of its abundance, prove a mainstay to the animal when other food is scarce. An illustration of such is reflected in the following: In the winter food of the raccoon, grasses and leaves form but 4.61 per cent of the bulk eaten, yet were found in 26 stomachs, constituting 20 per cent of all those examined. A discussion of the various foods is in order.

Buckwheat—Buckwheat was found in 20 percent of the animals examined. The grain is gathered from scattered stalks which have escaped the reaper, and the infrequent stacks that are left in the field by the farmer. This waste grain is a boon to the upland game bird and, at the same time, furnishes an important item of food for Ringtail. As much as a quart has been taken from the stomach of an eleven pound raccoon.

Apple—Frequently eaten, being found in 17.4 percent of the stomachs examined. The apples are often eaten in the frozen state and are an important food item in times of general food scarcity. Apple culls are inexpensive and might profitably supplement other food rations on fur farms.

Beechnuts—Beechnuts are the most important food of the raccoon during the fall and early winter, as they are with so many of our mammals, such as mice, squirrels, foxes, bears and even deer. Merriam (1886) has pointed out the importance of the beechnut crop in regulating the cycle of many mammals in the Adirondacks of New York. Quite

probably the crop influences the abundance of birds and mammals wherever extensive stands of beech occur. Beechnuts were found in 21.3 per cent of the animals examined.

Fruits and Berries—Occurring in 20 per cent of the stomachs, berries and fruit play an important part in the dietary predilections of the raccoon. The most important of these are wild grapes, but rum cherries, *Prunus serotina;* Virginia creeper, *Psedera* sp.; nanny berries, *Viburnum lentago;* ground cherry, *Physalis;* and partridge berries, *Mitchella*, are avidly eaten. As these are likewise important foods of game and other birds, plus a host of fur-bearers, including such valuable ones as the red fox and skunk, it would be wisdom to pay close heed to this crop in any program for wild life restoration.

Earthworms—The writer has found no mention in the literature of worms being eaten by these animals. It is truly surprising how important a part annelids play in the menu of the coon. Some stomachs contain remains of a dozen or more nightcrawlers (*Lumbricus terrestris*). What is even more amazing is that the raccoon will find them in large numbers in January. As Whitney has pointed out, the raccoon will emerge from hibernation during warm spells of December and January. After a day or two of warm weather, accompanied by considerable thawing, worms apparently move about and are easy prey for the raccoon. They were found in 19.9 per cent of the raccoons examined.

Corn—Every farmer knows the fondness of the raccoon for corn "in the milk." After it is in the shock, the animal is still partial to maize and feeds on it to a considerable extent. This fondness is reflected in its having been eaten by 12.5 per cent of the animals examined. Hunters know that a good place to start a coon is in the corn field. Corn might profitably be added to the table of captive animals.

Mice and Shrew—Small mammals are eaten as occasion affords. Remains of the meadow mouse, *Microtus p. pennsylvanicus;* deer mouse, *Peromyscus leucopus noveboraceusis*, and the short-tailed shrew, *Blarina brevicauda talpoides*, were found in 17.4 per cent of the animals examined.

Insects—The most important insect taken during the winter months is tipulid larvae. These occur in shallow streams or in the damp leaves bordering such water-courses. Eight animals had feasted upon these, while cutworms, beetle borers, crickets and adult hemiptera were taken less frequently. Insects were found in 18.9 per cent of the stomachs.

Acorns—Apparently the mast of oak is eaten more frequently than my records would indicate, for only 12.7 per cent of the animals had eaten acorns. Coon hunters are generally agreed on the importance of this food which, with beechnuts, forms one of the fattening items which induce hibernation.

Grasses and Leaves—Winter wheat, mosses, small green leaves of *Fragaria*, green hemlock needles and miscellaneous grasses, while not a bulky item, were found in 20 per cent of the animals studied. Like the red fox, green grass forms an important contribution to the winter

dietary of the raccoon. It may act as a tonic, as it apparently does among canines.

Crustacea—Crayfish are eaten as opportunity presents, while an occasional sowbug is consumed. Less than two per cent of the food during the winter, crayfish forms more than half of the food during the summer, according to the observations of Dearborn in Michigan.

Garbage—An occasional raccoon will risk the haunts of civilization to avail itself of the garbage pail and feast on offal and table wastes. Being more timid than the skunk, it does not resort as frequently to this ever ready and usually well spread table. But two animals had eaten garbage.

Birds—Two raccoons had eaten birds and both were woodpeckers (*Dryobates*). It is interesting to conjecture on the method of capture. The most likely is that Ringtail simply reaches in any chance hole it encounters and removes the sleeping bird.

From these observations, it can be seen that certain available foods might profitably be added to the feed of captive ranch-raised animals. Apples, buckwheat, various berries, corn and acorns can be had at a minimum of expense and might lower the cost of maintenance. Furthermore, such natural foods may well add to the lustre and color of the pelts. It would be well worth trying on a small experimental scale to determine the worth of such foods.

REPRODUCTION

In New York mating normally occurs during late January or during the first half of February. The normal gestation period is 63 days. Fur breeders assure me that pregnancy is seldom prolonged as in the mink. After mating occurs, the animals return to their winter sleep. Occasionally, the female fails to mate during the late winter. Such animals may breed during early summer and the young are born in August, according to Whitney (1931). This writer has taken young animals in New England during the fall weighing less than three pounds.

Strangely enough, the early stages of the raccoon have never been described. This is in keeping with the paucity of knowledge on the breeding habits of all our fur-bearing mammals. Careful observations on the early postnatal daily growth of such common species as the muskrat, opossum, fox, and a number of the mustelids, have still to be recorded. It is a virgin field for the young naturalist endowed with patience and enthusiasm.

The following notes, far from exhaustive, are based upon weekly observations of captive animals owned by Dorman Purdy, of Ithaca, N. Y.

AT BIRTH

The new born raccoon is well furred, the fur being particularly long (5 to 10 mm.) over the back and shoulders. The fur is yellow mixed with gray. The skin is black. The external black conch is well developed but unopened and devoid of hair. A small, short, black-haired area in front of the eyes foreshadows the mask which becomes pronounced when 10 or 12 days old. The limbs are well developed, the feet black while claws are light colored, bordering on pink. Facial vibrissae are well developed. The young average 75 grams (2.5 oz.) which is about one per cent of the weight of the mother.

The new born animals keep up an incessant chittering noise when disturbed. The adult carries one, sometimes two, as she runs from the nest box. At times they are grasped about the middle, sometimes by the neck.

ONE WEEK

Face with short fur, mystacial area with strong warty-like protuberances indicating the later appearance of vibrissae. The belly and fore limbs are rather scant haired, while the rest of the body is well furred. No teeth have appeared, eyes still tightly closed. The chittering notes continue and are heard much of the time. Average weight of two, one male and one female, 196 grams (6.5 ozs.).

NINETEEN DAYS

Two of the four young have opened their eyes; all have the external auditory meatus open. The animals average a pound. The leathery soles are jet black. Mask over eye very prominent. A light buffy line running over the eyes back to the ears. Back of the ears black, excepting the buffy tips. The tail has acquired the characteristic annulations, but is still scant haired. Fur heaviest over the nape and shoulders, being a uniform dirty buff tipped with lighter shade. Canines in both jaws erupted. Upper incisors just appearing as knobs while lower are through. With the opening of the eyes the young animals give a muffled bark, like a small dog. They are very active.

THIRTY DAYS

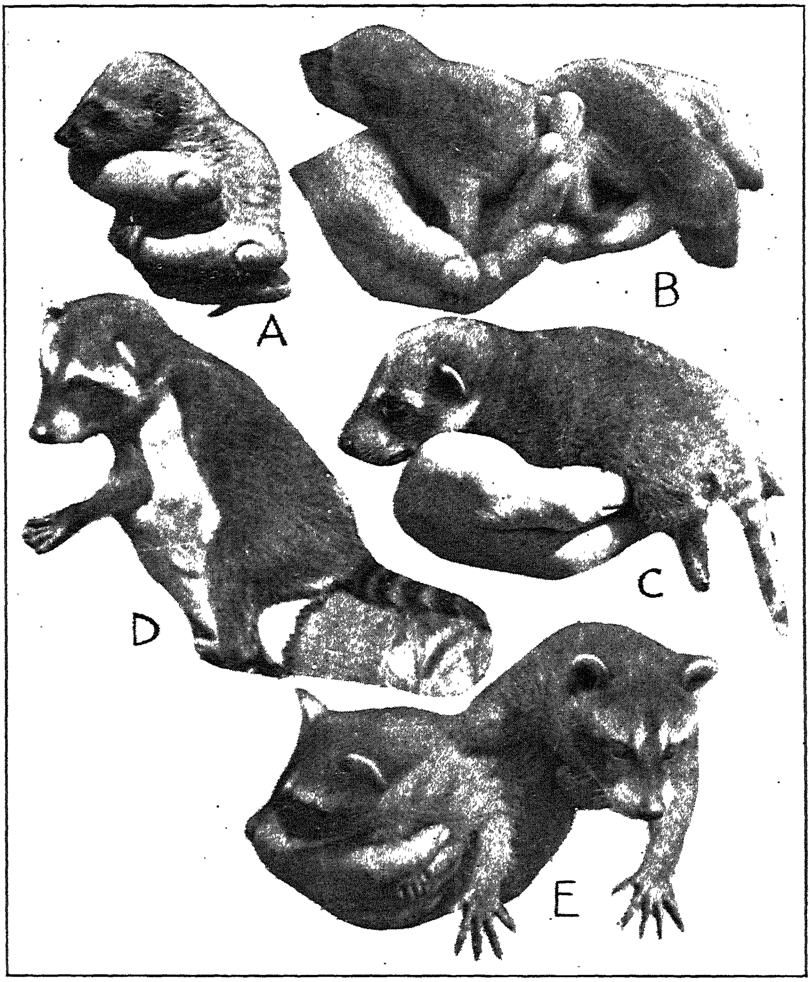
The young average 20 ounces each. Belly well furred, incisors completely erupted, while head remains proportionately larger than the rest of the animal. The youngsters crawl about readily and climb fairly well on a rough surface. They growl and bark with much spirit.

FORTY DAYS

The small coons are being weaned; now weigh 1.5 pounds apiece. Solid food is eaten and the rate of growth is rapidly accelerated.

The young animals at fifty days have apparently not left the nest box of their own accord. They now weigh two pounds, and spit and scratch with much energy.

The young continue with the parent well into the fall, and there is much evidence that, upon occasion, remain with the mother until the mating season approaches. Young animals taken during early November weighed 6, 6.5, 7, 7, 9, 11, 11.5, 12, 12.3, 13, and 14 pounds.



A. Day old raccoon. Note well furred condition. Fingers give index to relative size of the animal.
B. Week old raccoons.
C. Nineteen days old, when eyes first open.
D. One month old.
E. Six weeks old. Average weight two pounds.

IMPORTANCE AS A FUR-BEARER AND GAME ANIMAL

A few abortive attempts have been made by various states to determine the annual numbers of fur-bearers taken within their confines. Numerous difficulties are encountered in any such census. A large percentage of hunters and trappers fail to make a report, or where the census is determined by returns of licensed fur dealers, no account is made of the enormous numbers shipped to dealers outside the state.

Seton (1929) has estimated a primitive raccoon population in North America of 2,500,000. This author further suggests there might possibly have been 5,000,000 over the range; this figure being based on fur trade reports which show that for forty years prior to 1891 about half a million skins were marketed annually from North America.

The writer has carefully studied the fur reports of the various game commissions of a number of states. Where information has been lacking, some of the commissioners have furnished such information not available in the annual reports. When attention is directed to the manner of securing figures on the number of animals taken, it is readily seen that these figures are notoriously inaccurate, and *always too low.*

Based on reports from 1927 to 1934, I have estimated that there are taken each year by hunters and trappers half a million raccoons in fourteen states (California, Indiana, Iowa, Louisiana, Maine, Minnesota, Mississippi, North Carolina, New Hampshire, New York, Oregon, Pennsylvania, Texas and Virginia). These states cover but half of the animal's range in the United States. Furthermore, the area for which I have available figures, does not include such important coon producing states as Ohio, Michigan, Illinois, Oklahoma, Arkansas, and the great southeastern area, which alone encompasses 200,000 square miles of extremely productive raccoon territory. The most important fur-bearer in South Carolina and Florida is the raccoon.

It may readily be seen, then, that the number of ringtails taken annually in the United States may well exceed the million mark. Aside from the pelt value, which probably averaged a $2,500,000 annuity to the hunter over the past decade, the animal furnishes incomparable sport to many thousands each fall.

FUTURE STATUS OF THE RACCOON

The popularity and widespread use of raccoon pelts in the fur trade has increased the demand enormously during the past fifteen years. Drastic reduction of suitable cover, largely due to lumbering operations, has been instrumental in further reducing the habitat of this once plentiful fur-bearer. The most potent agency in depleting their ranks, however, has been the lack of sensible, short seasons, or the entire lack of any closed season for the animal.

One state gives no protection to the raccoon; two give complete protection. Of the remaining states, we find thirty different seasons. These vary in length from the wise November 1–December 15 season, to laws permitting the taking of raccoon over a five and a half month period.

It has been shown that the breeding season of the raccoon in the northern part of its range occurs during late January or early February. Three-quarters of our states permit the taking of ringtails during the breeding season. Fortunately, few animals are taken during mid-winter. The greatest loss occurs during the fall months, and is particularly severe when the season opens before November. At this period the young of the year are not sufficiently strong to make a sustained flight from a well-trained dog, and tree a few minutes after being started. An ideal season, at least in the Northern States, would extend from November 10 to December 31. The hunter, who takes 90 per cent or more of all animals which reach the market, would get in some excellent sport and at the same time be reasonably assured of hunting in the years to come.

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NOTES ON ROOT BEHAVIOR OF CERTAIN TREES AND SHRUBS OF THE ILLINOIAN TILL PLAIN OF SOUTHWESTERN OHIO

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The University of Cincinnati

In connection with studies of the vegetation of the Illinoian till plain,[1] certain peculiarities of root systems were observed which appear to be due to local environmental conditions. Furthermore, the adaptability of the root systems there displayed is an important factor in determining the ability of certain plants to occupy these areas.

The Illinoian till plain is a flat or nearly flat upland very imperfectly dissected by streams. In consequence, run-off is slow and drainage conditions poor. The fine impervious soil, a deeply weathered and leached drift, further accentuates the poor drainage conditions. Except in periods of extreme drought, the water table is close to the surface; in wet seasons and almost always in spring, it coincides more or less with the surface. In the shallow depressions, water stands sometimes for many months. Such soil conditions result in poor soil aeration.

Responses in direction of root growth to the poor drainage and aeration conditions are evident in the superficial root systems of many of the plants. The present paper is intended to give an idea of root behavior displayed, but is in no sense a detailed study of root systems. Rather it is suggestive of the importance of root behavior in an extreme environment as a factor in species competition and forest development.

Certain of the trees in wet soil develop swollen bases or buttresses and roots widely spreading at the surface. White elm (*Ulmus americana*) has roots near the surface which arch above the ground in the wettest places. It may also have prominent buttresses which sometimes give a broad pyramidal form to the tree base (Fig. 1B), or which extend out many feet in narrow plank-like projections (Fig. 1A). A grotesque and almost inexplicable form is shown in Fig. 1C.

[1]Forests of the Illinoian till plain of southwestern Ohio. Ecol. Mon. 1936.

The superficial and spreading habit of the roots of beech (*Fagus grandifolia*) is even more pronounced than is that of white elm (Fig. 2A, B). The large spreading roots are at the surface of the ground and even arch above it; a dense mat of fine fibrous roots fills the upper three to five inches of soil. The main roots at the trunk may amount to props elevating the trunk so that at its base it is not in contact with the soil (Fig. 2C). Arching of the main roots at or near the trunk is sometimes seen (Fig. 2D). In situations where the large roots are exposed, beech sends up abundant root shoots. The shallowness of the root systems of beech in wet and poorly aerated soil resulted in high mortality of this tree in depressions in the 1930 drought.

Large sweet gum trees (*Liquidambar styraciflua*) occasionally have superficial roots. In this species there is no accompanying enlargement or buttressing of base (Fig. 1D). Examination of the root system of very young trees shows strong development of laterals and pronounced twisting or curling of the tap root.

The larger roots of red maple (*Acer rubrum*) commonly spread at or near the surface of the ground, though not in as pronounced a manner as do those of white elm and beech.

Pin oak (*Quercus palustris*) develops a strong tap root; even in this species, however, the tap root may become considerably bent or twisted, but fine superficial roots do not develop.

The superficial root habit is assumed partially in response to poor aeration in saturated and water-logged soils. This will not, however, account for such peculiar forms as shown in Figures 1C and 2D; neither will it account for the arching habit of some, unless this position was taken when the water table was much higher than now. Frost action in a fine-grained soil is a factor tending to heave roots and young trees. This is sometimes evident in the case of saplings about one inch in diameter. Hence, while largely a response to soil water and air, the features of tree roots here mentioned may be due in part at least to the heaving action of alternate freezing and thawing.

The assumption of shallow root systems by elm, red maple and beech, particularly, increases root competition and may be a factor in accounting for the paucity of vegetation in the ground layer in communities in which these species are important

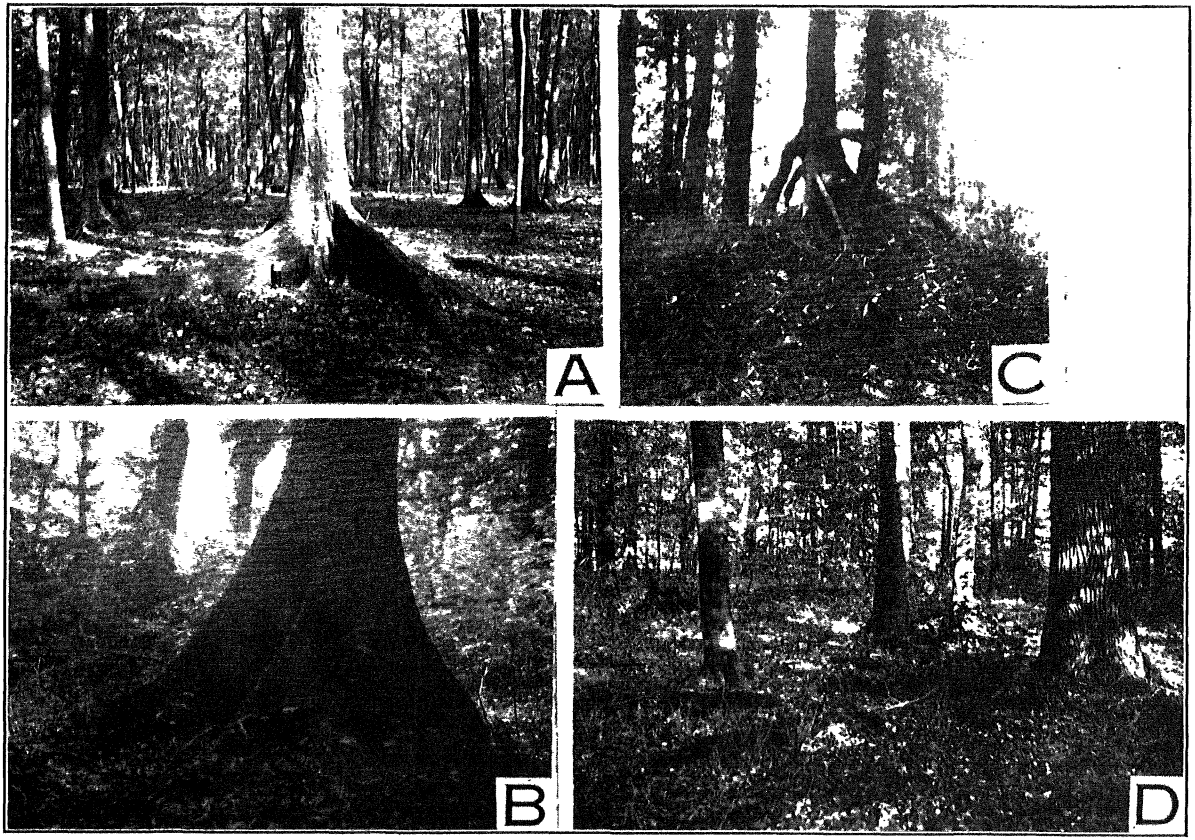

FIG. 1. A. Base of white elm showing "plank buttresses." The Thermos bottle gives scale.
B. Pyramidal buttressed base of elm.
C. Base of young elm; no erosion or removal of soil was possible in the situation in which the tree is growing.
D. Sweet gum with spreading superficial roots. Tree in wet soil in beech-white oak-sweet gum community.

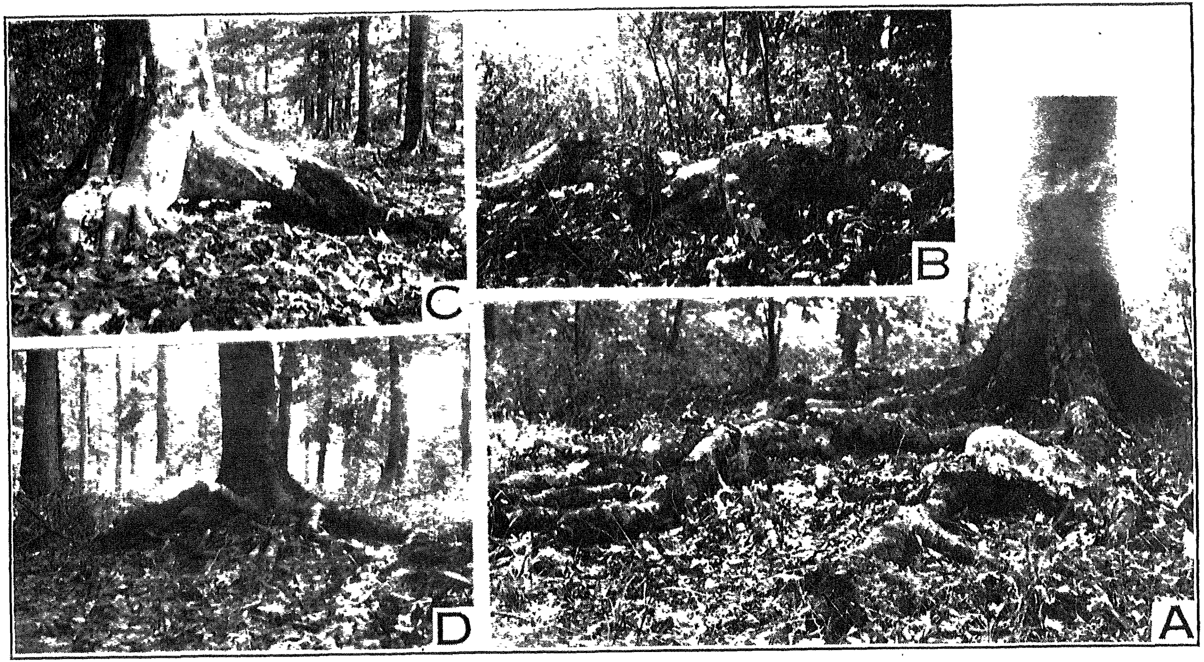

FIG. 2. Variations in form of beech.

A. Roots of large tree crawling on surface of ground; these superficial roots afford favorable habitats for a variety of mosses and lichens.
B. Close-up view of arching root.
C. Trunk elevated above forest floor by three large roots.
D. Peculiarly arching roots of beech.

members. In contrast, the greater abundance of shrubs and herbaceous plants in certain pin oak and white oak communities, both primary and secondary, may be due to the lesser root competition in these communities.

Many of the shrubs of the wet flats have superficial root systems. Spiraea bushes (*Spiraea tomentosa*) can frequently be lifted from the ground with almost no effort; most of the roots spread in the shallow layer of leaf litter; few penetrate the mineral soil beneath (Fig. 3). *Ilex verticillata* is similar in root habit (Fig. 4A, B, C). The habitat in which these shrubs commonly grow in the till plain is characterized not only by the high water table and poorly aerated soil, but also

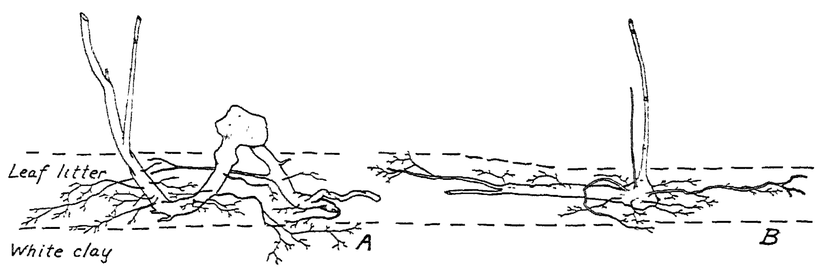

FIG. 3. Root habit of *Spiraea tomentosa*. Roots largely confined to layer of leaf duff on "white clay" or Clermont silt loam.

by the formation of a definite layer of leaf duff of the type described by Romell and Heiberg.[2] It is in this duff that root development takes place. It is possible that the absence of certain of the more characteristic shrubs of the till plain communities from some of the larger areas of the flats may be due to drying out during extreme droughts; the position of the root system makes this highly probable.

Some herbaceous plants in their root systems show a response to soil conditions. Both shallow and penetrating root systems are found. In some, as *Stellaria longifolia*, the roots are in the leaf duff. Regardless of situation, *Gentiana Saponaria* has a deeply penetrating root system. Such plants as *Gnaphalium polycephalum*[3] and *Sabbatia angularis*, both of which have tap roots, assume shallow root systems in poorly aerated soils.

[2]Romell, L. G. and S. Heiberg. Types of humus layer in the forests of northeastern United States. Ecol. 12: 567–608. 1931.

[3]Guhman, Helen. Variations in the root system of the common everlasting (*Gnaphalium polycephalum*). Ohio Jour. Sci. 24: 199–208. 1924.

Peculiarities of root systems are assumed in response to environmental factors—high water table, poor soil aeration,

FIG. 4. Root habit of *Ilex verticillata*.
A. General view of root system.
B. Large root as seen from above showing extensive development of laterals all essentially in horizontal plane as shown in C.

leaf duff formation, and occasionally frost action. The assumption of superficial root systems by certain trees increases root competition in surface soils.

THE INHERITANCE OF ALLERGIC DISEASE*

ALEXANDER S. WIENER

PRELIMINARY REPORT

There seems to be no unanimity of opinion as to the mode of transmission of allergic disease. According to Cooke and Vander Veer (1) and Spain and Cooke (2), allergy is transmitted as a simple Mendelian dominant. In direct contrast, Adkinson (3) maintains that her findings favor a recessive mechanism. Furthermore, Richards and Balyeat (4) suggest that the condition is inherited as a "partial dominant."

An analysis of our own (5, 6) family studies (66 complete families with 250 children), as well as data already published, failed to support either the simple dominant or recessive theory. The dominant theory does not explain why in more than half of the pedigrees both parents are normal. The recessive theory is refuted by the existence of pedigrees in which both parents are affected, yet some of the children are normal.

The author presents for consideration a new theory of heredity of allergic disease. Under this theory, allergic disease is transmitted by means of a single pair of allelomorphic genes, H and h, where h determines allergy, and H is the contrasting normal gene. Three different genotypes are possible.

(1) Genotype HH—pure normal.

(2) Genotype hh—pure allergic. In individuals of this genotype, symptoms of allergic disease appear before the age of ten years.

(3) Genotype Hh—The majority of these individuals remain apparently normal throughout life, though they transmit the abnormal gene h. Depending upon environmental conditions, a certain proportion will develop allergic disease, but the symptoms do not appear until after puberty.

The existence of two sorts of allergic individuals is supported by their bimodal distribution when classified according to age of onset. Moreover, statistical analysis of the authors' own findings (5) in family studies and data previously published

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lends additional support to the theory. One finding that remains to be explained is the excess of males over females among those developing allergic disease before puberty.

In 55 of the families studied by the author, the simultaneous heredity of the allergic disease, the blood groups, MN-types, and eye color were presented. Statistical analysis failed to reveal any evidence of linkage among the genes determining these traits (6).

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Ovulation in Women

This volume, one of the series on Medical Aspects of Human Fertility published under the auspices of the National Committee on Maternal Health, is an extremely well-written account of the time of ovulation, the possible time of conception, and the "safe period" in women. It is entirely free from religious prejudice, or bias of any sort. The style is delightful and the analysis keen and critical. A great deal of factual and experimental material, both on human and monkey subjects, is presented and discussed. The book is not too technical to be read and understood by the layman, yet is of absorbing interest to the biologist. The evidence for mid-interval ovulation for women, and the relatively safe period outside of days 8 to 21 of the cycle, while not complete, is considered the most plausible at present.—L. H. S.

Time of Ovulation in Women, by Carl G. Hartman. x+226 pp. Baltimore, The Williams and Wilkins Co., 1936. $3.00.

The Alcohol Problem

Not a diatribe, not a preachment, not a sentimental fable, not a pseudoscientific emotional appeal, but a brief and calmly scientific discussion of the physiological effects of alcohol upon the human body is this little book which represents one of the newer trends in moral education wherein the traditional dictum of "Thou shalt not!" is replaced by "These are the facts. What should you do about them?" The author presents these facts in story form expressed in simple language, which in no way lessens the accuracy of the material presented, and in lucid, flowing, and at times humorous style which should appeal both to the youths of grades 7 to 12, for which it is primarily intended and to grown-ups as well. The author wisely avoids getting too much involved in the controversial social aspects of the problem, but he has written a straight-forward and honest account in which American youth is urged to form personal judgment on the basis of widely accepted facts.—B. B. M. MEYER.

Alcohol Talks to Youth, by Howard E. Hamlin. 63 pp. Columbus, Ohio, School and College Service, 1935. $0.24.

NEW TABANIDAE (HORSEFLIES) WITH NOTES ON CERTAIN SPECIES OF THE LONGUS GROUP OF TABANUS[1]

CORNELIUS B. PHILIP

While examining representative material of western species of horseflies in the collection of the late Professor J. S. Hine, it soon became evident that the status of some species could be clarified only by a revision of certain species related to the difficult *longus* group of *Tabanus*. From time to time, various students of the family have contributed data on the group, including Hine himself, and the latest contribution is that of Fairchild (1934). The present notes are submitted in the hopes of providing additional diagnostic information without any pretense to a complete treatment of all the related slender-bodies species in North America.

The author is indebted to the authorities of the Ohio State Museum, particularly Mr. Edward S. Thomas, for permission and facilities to study Professor Hine's extensive collection and to make comparisons with his own; also to Dr. Alan Stone of the U. S. National Museum for generous comments and data as cited below.

T. longus O. S. Specimens are before me from Pennsylvania, Ohio (1 ♀, Lancaster, by Bequaert), Kentucky and Arkansas (Yell Co., by Schwardt). There seems to be considerable variation in robustness of the palpi and of the body in general. The Arkansas specimens are largest (15 mm. in one instance) with elongate palpi attenuated for nearly half their length, a distinct dorsal prominence on the antennae and the abdomen not narrowed posteriorly, the 6th tergite reduced in depth and not as elongated as in typical *longus;* these are probably distinct and more closely related to "*T. sp.*" to be described by Stone. The Kentucky specimens, on the other hand, show the usual body form, but the palpi are relatively short and somewhat incrassate to the bluntly rounded apices. It appears to be a late summer species, like *sackeni*, seldom appearing before August.

T. sackeni Fairchild. This author, in 1934, correctly separated this species from *T. longus*, recording it from as far west as Missouri and Ohio. The writer had also discovered its presence among Hine's material and noted but one specimen of true *T. longus* from within Ohio in a considerable series of this species (identifications confirmed

[1]Contribution from Rocky Mountain Laboratory, United States Public Health Service, Hamilton, Montana.

by Dr. J. Bequaert). Additional records include Arkansas (specimens received from H. H. Schwardt) and Kansas; while Stone adds Va., Ind., and Okla. It has been taken in Ohio between July 23 (Thomas) and as late as September 7 and is apparently not uncommon. The eyes of the female (relaxed) show traces of two greenish bands on a purple ground.

The male (which Fairchild apparently lacked) is easily associated.

Allotype—Length, 14 mm. Head subhemispherical, area of enlarged facets well marked, occupying almost three-fourths of the total area. Antennae very slender, about half the width of those of the ♀, but the elongate shape characteristic; red, the annuli sharply black. Palpi very slender, second joints about two and one-half times as long as broad, covered with long, white hairs and a few scattering black ones. Thoracic lines not as distinct, abdomen more slender, rather pointed, otherwise the abdominal pattern, leg colors, vestiture and completely hyaline wings compare typically with the ♀. "Neotoma," Hocking Co., Ohio, July 24, 1932. Edw. and John Thomas. In the collection of the Ohio State Museum.

Additional males, one each from Onaga, Kansas, July 21, 1901, in the same collection, and from Hinckley, Medina Co., Ohio, August 24, 1904, in the collection of the author. These are probably the males mentioned by Hine (1914) under his form 1 of *longus*.

T. fulvulus Wied. Typically, the annuli of the antennae, femora, fore tibiae distally and tarsi are blackish. Stone considers as true *fulvulus* only the variant with yellow face, palpi and pleurae described by Osten Sacken in his "observation" (1876, p. 452). The degree of infuscation of the appendages varies so markedly as to suggest a composite species, and certain specimens from the South are markedly pallid in this respect, as pointed out by Hine (1914).

Insufficient material and some intergradation among the females, especially in color intensity, makes it unwise to treat this form in more than a varietal sense at present.

Var. *pallidescens* n. var. Female—Length, 13.5 mm. Differs from typical *fulvulus* in having front more distinctly convergent below, the callosity "faded brown," more elongate and not separated from the eye margins by narrow pollinose lines; face below the insertion of the antennae whitish pollinose and pilose with hardly a suggestion of buff, palpi pale creamy; thorax light yellowish instead of golden, pleurae sharply white pollinose and pilose, legs practically concolorous, pale reddish, darkening slightly on the apices of the fore tibiae and on the fore-tarsi, and some blackish hairs on the tips of the hind tibiae; the wings more hyaline, the dilute yellowish along the costal margin hardly discernible; the abdominal pattern is essentially the same but less dark caudally.

Male—12 mm. Eyes bare, dark brownish, area of enlarged facets large, very pronounced. Antennae entirely red, slender, with a distinct tooth, the annuli about two-thirds length of the third joint proper. Palpi pallid, pointed apically with long white hairs. Thorax yellowish on the disc, pale grayish laterally and ventrally, unstriped. Legs concolorous reddish, a little darker distally on the front pair. Costal

cell of wings dilute yellowish. Abdomen orange-yellow, pattern indistinct.

Holotype, female. Blue Mts., Miss., June 10, 1914, H. H. Carter. In the collection of the author.

Allotype, male, Starkville, Miss. "T. C.," May 31, 1921. In the collection of the Ohio State Museum.

Paratype females. Tenn., 1; Ark., 1; Ga., 5; Miss., 1, and La., 5. In the above collections also.

A specimen compared by Hine with the type of *T. fulvofrater* Walk. has red antennae, but he says (MS notes), "The (type) specimen is much soiled and antennae broken," and his other comments indicate the name is hardly available for this pallid variety. The male with all red antennae studied by Osten Sacken may be this form and also perhaps the females he describes with pale face, palpi and pleurae and "brownish yellow" femora; Fairchild does not include a statement regarding Osten Sacken's original three specimens in his redescription of the Mus. Comp. Zool. material.

T. sagax O. S. The type of *T. baal* Twns. (examined through the kindness of Professor Beamer of the University of Kansas) was greased and when cleared is a well preserved specimen of *sagax* with gray front, cheeks, pleurae and broad, abdominal stripe. *T. dawsoni* Phil. is also a synonym.

Two rather definite forms have been regarded as *sagax* by Hine and others, the typical one being rather robust, 13–15 mm., the front of the female about three times as tall as broad, the 3rd antennal segment elongate (length is to breadth about as 3.5 : 1), the annuli less than half the total length of the segment (1 : 2.5), the palpi yellowish, the abdomen chiefly reddish yellow with a wide grayish pollinose, mid-dorsal stripe. The other form is darker with a narrower front and will be described later by Stone and is the one, comparison with which was responsible for the establishment of *dawsoni*.

The male of the typical form has not heretofore been described.

Allotype—Length, 13.5 mm. Area of enlarged facets of the eyes not pronounced but definitely delimited, about two-thirds of the total area. Antennae of the same elongate shape as in the ♀, but a little more slender, red, the annuli sharply black. A few scattering, long black hairs among the white pile along the facial margin of the eyes and on the underside and apex of the second palpal joints. Latter rather swollen, about twice as long as wide, pale yellow. Compared to the ♀, the whole body is covered with longer pile, that on the pleurae more yellowish, and the abdominal pattern rather indistinct with a fulvous suffusion, the mid-dorsal black crescents hardly evident except by dark hairs, the characteristic mid-dorsal stripe evident although creamy instead of gray pollinose, and the elongate, black, integumental spot in the middle of the second segment (usually obscure in the female) pronounced. Carlisle Junction, Pennsylvania, June 27, 1917, J. N. Knull. In the collection of the author.

T. longiusculus Hine. Although the describer compared this with *longus* as "smaller and darker" (he undoubtedly had then unknown

T. sackeni confused with the latter) it nevertheless bears a striking general resemblance to true *T. longus* O. S. in size and color. The front in this is somewhat narrower, however, and the callosity perceptibly taller than wide; the antennae are a brighter red and the third segment chunkier, while there are darker shades on the femora accentuated by blackish hair at least dorsally on the last two pairs, best emphasized by end-on view. These hairs in the *longus* examined have been almost entirely pale. Infuscation of the femora, especially of the bases of the two hind pairs described by Hine as "almost black," varies somewhat and in two of the eight co-types seen by the writer, is almost evanescent. In one of the co-types otherwise comparable, the third antennal segment is drawn out resembling that of *sagax* in shape.

A male taken by the original donor, A. H. Manee, in the type locality a year after the description appeared, is here described.

Allotype—Length, 12 mm. Easily associated with the ♀, but the body, legs and wing veins not so dark, nearer a pure brown. Eyes with area of enlarged facets distinct, but not as pronounced as seen in some glabrous-eyed species, occupying slightly more than half the total area. Antennae bright red, annuli sharply black, narrower than in the ♀. Second palpal joints pale creamy, about twice as long as thick, distinctly downward pointed apically, with white and black hairs intermixed, white only on the basal segment. Proboscis very short. Thorax with faint brownish lines and appressed yellowish hairs among the dense, upright, smoky ones on the disc. Entire venter with less of the pronounced frosty pollen of the ♀. Legs brownish, darker distally and on the femora because of rather dense black hairs over the whole fore femora and dorsally on the last two pairs. Abdominal pattern typical, but the stripe and spots yellow rather than gray.

Southern Pines, North Carolina, May 22, 1908. In the collection of the Ohio State Museum.

Two females (one with nearly concolorous legs) apparently from the original Georgia series, were also studied in the University of Kansas collection bearing the photographic labels of "*T. longulus* det. by Hine." The species has been reported from Louisiana (Jones and Bradley).

T. zythicolor n. sp. (Latin, beer-color). Heretofore placed with *T. longus* O. S., but the entirely pale red, relatively shorter antennae, average smaller size (9.5 to 13 mm.) and lighter brownish-red color, especially of the thorax, with a complete yellowish suffusion of the wings, and the narrower front with lack of connection between the yellowish frontal callosity and the dark brown, ovate median callosity above in the females are distinctive.

Female—Length, 13 mm. Eyes glabrous, indications of two stripes (relaxed). Front parallel sided, about four times as high as wide, yellowish pollinose, the callosity fulvous, quadrate, occupying the full width of the front, a little taller than broad and widely separated from the small, dark brown ovoid median callus. Subcallus fulvous pollinose, face and cheeks creamy, with pale hairs; palpi about three-fourths of the length of the stylets, pale yellowish with sparse black and white hairs intermixed, moderately swollen basally. Antennae, including annuli, entirely light reddish, rather broad, little excised. *Thorax*

pale brownish-red, with appressed, pale golden hairs and practically immaculate. Legs pale reddish. Wings with costal cell yellowish and a paler suffusion over the entire surface. Halteres brown. *Abdomen* elongate, of a light reddish-brown ground color, with narrow, pale incisures and three rows of triangles, the median triangles narrow, but not acuminate anteriorly, widening abruptly on the posterior margin; the appearance is thus a narrow median pale stripe with widened portions barely connecting across the posterior segmental margins with the rounded pale lateral spots. In certain lights, the latter hardly touch either margin. Venter pale reddish.

Male—Length, 12.5 mm. Essentially similar to the female but a trifle darker brown over the whole body including the appendages, except the palpi which are pale yellow and rather slender, bluntly rounded apically, about twice as long as thick. Fore-tarsal claws subequal, black. Not much difference in the size of the eye facets.

Holotype—Female, Oakdale, North Carolina, August 22, 1902, F. C. Sherman.

Allotype—Male, Cape Charles, Virginia, July 1–20, 1933. Dwight Buchanan. Both in collection of the author.

Paratypes—Two females, Raleigh, North Carolina, July 18 and September 2; 1 female, Brinkleyville, North Carolina, August 6; 1 female, Princeton, North Carolina, July 28; 1 female, Lagrange, North Carolina, mid-July; 10 females, Mimsville, Georgia, July 7 to September 6. In the collections of Ohio State Museum, Museum of Comparative Zoology, Cambridge, Mass., U. S. National Museum, and Rocky Mountain Laboratory at Hamilton, Montana.

Little variation is to be seen except in size and in distinctness of the abdominal pattern according to the preservation of the various specimens. Stone adds the states of Va., S. C., Tenn., Ala., Fla., Ark., La., and Okla.

T. gracilis Wied. Most of the specimens studied from North Carolina, Florida and Louisiana have antennae entirely bright reddish, but occasionally there is a dark-brownish suffusion distally which involves the whole third joint as in a specimen kindly compared for me with the type by Dr. H. Zerny, of the Vienna Natural History Museum. The species seems otherwise quite uniform.

T. abactor n. sp. (Latin, cattle-thief). Has been confused heretofore with *T. erythraeus* Big. (*T. rubescens* Bell., syn.[2]) of Arizona and Mexico. The abdomens of both have somewhat the same light chocolate-brown ground color with three rows of prominent pale-brown triangles reaching almost or quite across the segments, but this color occupies the thorax of the females as well in the present species, and

[2]The synonymy is in manuscript of the late Professor Hine who studied Bigot's type at the British Museum; but the specimen compared by him is actually *T. abactor*. Bellardi specifically mentions the enlarged first antennal segment in his type, and Austen writes of this segment in Bigot's type, "unusually incrassate, as described in your letter, and projects like a hood above the small second segment." Hine's synonymy is, therefore, correct, although his homotype is *abactor*. *T. rubescens* Bell. is preoccupied by *rubescens* Macq. while *T. erythraeus* Big. (type in poor condition) has page priority over *Atylotus erythraeus* Big. from the Argentine.

the glabrous eyes, normal rather than swollen first antennal joints, presence of a faint cloud at the bifurcation of vein R5 of the wing, and the larger frontal callosity of the female will differentiate it.

Female—Length, 14 mm. Eyes naked, with two green stripes on a purple ground (relaxed). Front grayish pollinose, rather narrow, very slightly convergent below, the dark brown callosity occupying its full width and tapering abruptly into a narrow line above; on either side of the latter a patch of dark brown pollen with blackish pile, which is obsolescent when viewed from above. Subcallus and palpi pale-creamy pollinose, the latter tapering gradually and not quite as long as the stylets, covered sparsely with appressed black and white hairs; face and cheeks whitish pilose and pollinose. Antennae dark reddish, the annuli black, and the third joint broad, chunky, with little excision. *Thorax* and scutellum brown, covered with appressed gray hairs and indications of four brown lines almost the full length of the disc. Antealar tubercles with fine black and white hairs intermixed. Pleurae and fore coxae creamy-brown pollinose and whitish pilose. Fore legs with femora, distal half of tibiae and tarsi blackish-brown; front tibiae basally and two hind pairs of legs reddish-brown. Halteres brown, yellowish on the disc. Radial sector of wings not appendiculate, the stigma pale brown, and the costal cell and cross-veins are very faintly tinged with yellow, in addition to the faint cloud at the bifurcation of R5. The abdominal triangles completely divided by the dark brown intervals, i. e., not connected across the incisures, the median triangles equilateral and paler than the lateral, semi-rhomboidal spots. Venter reddish-brown, darker toward the tip, with a wide median stripe of minute black hairs its full length.

Male—15 mm. A little darker than the ♀, especially on the thorax, area of enlarged facets not as marked as in some glabrous-eyed species, a single green band across the purple area of small facets. Palpi fulvous, rather short, about twice as long as thick. All femora blackish. Otherwise as in the female except for the usual sexual differences.

Holotype, female, Eastland Co., Texas, May 27, 1921, Grace O. Wiley. In the collection of the author.

Allotype, male, Kerryville, Texas, June 19, 1908; F. C. Pratt (Bishopp No. 5410). In the collection of the Ohio State Museum, Columbus, Ohio.

Paratypes—One male, same data as holotype, and one female, same data as allotype (August 5), in the collection of the author; 18 females from Eastland County, and from Austin, Brownwood, Kerryville, Dallas, Doss, Uvalde, Batesville, Sonora, Bardsdale, Lackey, Bunt, San Marcos, Hacienda, Mason, Regan Wells and Con Con, Texas. Dates are fairly distributed between May 27 and September 20; one female from Sonora is labeled October, 1921. In the collections of the Ohio State Museum, U. S. and Canadian National Museums, Museum of Comparative Zoology, University of Kansas, California Academy of Sciences, and the Rocky Mountain Laboratory, U. S. Public Health Service, Hamilton, Montana. One male, Pearsall, Oct. 9, and 3 females, Johnson Co., July 1, Texas Coll. Reinhard, in Univ. of Texas Collection. Length, 12 to 15 mm.

Some variation is seen in abdominal coloration of the paratypes where a smoky suffusion may spread forward from the tip involving especially the venter.

The species is some like *T. sackeni* Fchld., but the abdominal triangles are more pronounced and angulate, the third antennal segment is wider and shorter, the front of the female is less convergent, the callosity merging broadly with the median callus above, and the fore femora of the female and all femora of the male are dark brown; the wings of *T. sackeni* have no traces of clouds on any of the crossveins.

The specimens from Texas referred to by Osten Sacken (1876, p. 448) in the last paragraph under *T. longus*, and by Fairchild (1934, p. 143) under *T. fulvicallis* probably represent this species. Stone lists this species from Kansas and Oklahoma in addition to Texas and comments that the "abdomen of *erythraeus* is distinctly more orange-brown than in *abactor* and the colors more contrasted" in his considerable series.

Professor Sanborn, of the University of Oklahoma, informs me this species is very amenable to confinement and most useful in their transmission studies of anaplasmosis in cattle. Specimens from him are *T. abactor*, and it seems likely the "*T. gracilis*" reported by Sanborn et al. (1930) were actually *T. abactor*, since the former occurs only rarely as far west as Louisiana. He has taken it from mid-May to mid-September and observes it to be their most troublesome species, as many as three dozen being seen on an animal at one time in mid-season. Their experiments (unpublished) indicate this species as a potential vector of the disease.

Since Fairchild (1934) overlooked including his intended key to the *longus* group, an analytical dichotomy is here appended to include also related species with elongate, brownish bodies and three rows of abdominal spots treated above.

1. Legs practically concolorous, brownish-red (fore tibiae and tarsi sometimes darkened distally) 5
   Legs with at least the fore femora almost black or decidedly darker than the fore tibiae basally; legs therefore really bicolored 2
2. Wings with faint clouds on outer cross-veins and costal cell hyaline; lateral abdominal spots angular, semi-rhomboidal; median callus linear, not widened above its connection with the frontal callosity; fore legs only (♀) bicolored .... **abactor** n. sp.
   Wings hyaline with yellowish costal cell; lateral abdominal spots rounded (except *texanus*); median callus usually widened above or disconnected from callosity; all femora darkened at least basally 3
3. Lateral abdominal spots angular and continuous, the dark intervals not curved behind; front of female broad, the callosity quadrate .. **texanus** Hine
   Lateral abdominal spots rounded, isolated at least inwardly and below by paired crescentic dashes; front of female moderately broad or narrow, the callosity usually plainly taller than broad 4
4. Front of female narrow, somewhat convergent below, the callosity small; thorax essentially unstriped; body, including face and palpi, chiefly yellow .... **fulvulus** Wied.
   Front of medium breadth, parallel-sided, the callosity relatively large; thorax distinctly lined; body chiefly light brownish, the face and palpi whitish .... **longiusculus** Hine
5. Wings, including costal cells, hyaline 6
   Wings, with at least costal cells dilute yellowish 7

6. Third antennal joint elongate, red, the annuli sharply black; front of female convergent below, frontal callosity separated from the median, **sackeni** Fchld.
   Third joint short, compact, predominately black; front of female narrow parallel, frontal callosity continuous with a narrow, median line above, **fulvicallus** Philip
7. Antennae entirely red, occasionally brownish.......................... 8
   Antennae black distally, at least the annuli.......................... 10
8. Thorax unstriped, dusty golden pollinose; front of female narrow, convergent below, the callosity small and elongate, **fulvulus** var. **pallidescens** n. var.
   Thorax brown, more or less gray striped; front parallel-sided, the callosity relatively larger.......................... 9
9. Abdominal triangles angular, the central row large, acuminate just before the margin of each segment; the front of female broad, the calli usually connected..........................**gracilis** Wied.
   Abdominal spots rounded laterally, the central row or triangles attenuated anteriorly on each segment forming a narrow, continuous gray stripe; front moderate, the calli not normally connected....**zythicolor**, n. sp.
10. Abdominal pattern chiefly brown, rather dark, the mid-dorsal row of connected gray triangles forming a narrow stripe; thorax usually distinctly gray striped..........................**longus** O. S.
    Abdomen chiefly yellow, or light reddish, the median gray stripe or yellow triangles frequently broad; thorax not or imperceptibly lined... 11
11. Abdomen usually reddish yellow with a broad, pale pollinose, middorsal stripe its full length, the lateral spots indefinite; 3rd antennal segment elongate, the basal prominence hardly perceptible; front of female about three times as high as inferior width..........................**sagax** O. S.
    Abdomen usually yellowish, with paired, brownish dashes enclosing a rather narrow yellow stripe; 3rd antennal segment with basal angle more distinct; frontal height of female usually four times its width, "**T. sp.**" (to be described by Stone)

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Stone, Alan. Correspondence.

Personality

A concise, elementary introduction to the subject of personality. In the words of the author, "The content and order of presentation have grown out of a course which has been given to beginning college students with some degree of success." This book should be of use to persons seeking just such a treatment of the topic.

With a task as unwieldy as that of clearly presenting "an analysis of personality on a factual, scientific basis" in simple, straightforward style, and in language comprehensible to the neophyte, the author has succeeded well.

—M. M. Parker.

Personality, by Harold V. Gaskill. vi+50 pp. New York, Prentice-Hall, Inc., 1936.

THE GROSS ANATOMY OF THE ALIMENTARY CANAL OF SOLUBEA PUGNAX (FAB.) (HETEROPTERA, PENTATOMIDAE)

A. L. HAMNER,
State College, Mississippi

At the present time the alimentary canal of the Heteroptera has been little studied. In view of this fact and because of the confusion which has arisen in the terminology and the inaccessibility of the more important papers to most students, a short paper dealing with the gross anatomy of the canal of one of the members of this order and bringing the more important facts together seems avdisable.

The writer wishes to express his appreciation to Dr. C. H. Kennedy, of Ohio State University, for his advice during the course of this rather limited work and in the preparation of this paper, also for access to papers in his private library which otherwise would not have been available.

Stomodeum—The salivary pump opens into a long semi-transparent oesophagus (Fig. 1, OES) which extends from the anterior part of the head, passing between the rather large circum-oesophageal connectives and to about the middle of the prothorax.

Mesenteron—The oesophagus opens into a rather large first stomach (Fig. 1, 1ST. S), which extends posteriorly as far as the third abdominal segment. This was termed the crop by Malouf (1933), "premier poche de ventricule chylifique ou stomac," by Dufour (1883) and the first stomach by Glascow (1914). Malouf (1933) states that in *Nezara viridula* L. the oesophagus and crop have similar histological characters, there being "an innermost layer of folded epithelium composed of cubical cells and lined by a thin internal intima." However, he also states that "External to the epithelium is a layer of circular muscle fibers. External to these is a layer of longitudinal muscle fibers; while enveloping all is a nucleated peritoneal membrane." Malouf apparently has made an error in describing the muscles of this region because Harris, in an unpublished thesis, has shown that the longitudinal muscles in *Murgantia histrionica* are surrounded by a layer of circular muscles in the oesophagus. He also shows that in the "crop," as termed by Malouf, the longitudinal layer is external to the circular layer. Malouf has evidently interpreted some other structure as the intima in this organ. Ancona (1932) figures a long structure similar to this in *Alizires taxcoensis*, a Mexican species, which he divides into three parts—the "proventriculo," the "intestino medio" and "estomago." In the specimens of *Solubea pugnax* examined this organ varied considerably

in shape, apparently due to the varying food content. No structure was found which could be called a proventriculus. It is probable that

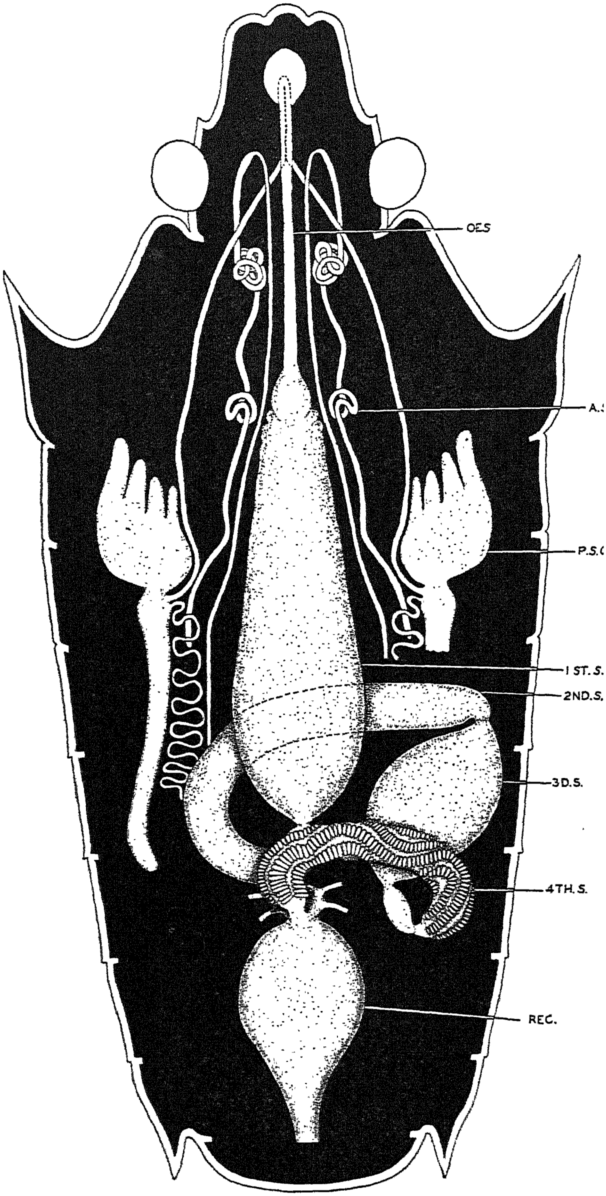

FIG. 1. The gross anatomy of the alimentary canal of *Solubea pugnax* (Fab.).

Ancona misinterpreted this organ when he divided it into a "proventriculo," an "intestino medio" and "estomago."

The first stomach, after a distinct constriction, passes into a tubular organ, the second stomach (Fig. 1, 2ND. S.) which turns dorsally and then anteriorly and ventrally, passing in its normal position under the first stomach. This organ has been designated as the "true first stomach" by Malouf, the "portion filiforme" by Dufour, "intestino posterior" by Ancona, and the "second stomach" by Glascow. After a distinct constriction it turns abruptly posteriad and passes into a globular organ, the third stomach (3D. S.). This organ is the "second stomach" as termed by Malouf, the "second poche gastrique" by Dufour and the "third stomach" by Glascow. This globular portion tapers posteriorly from the middle and passes into a very short organ which has been termed the "third stomach" by Malouf, "col de cette poche" by Dufour, while Glascow combines it with the caecal part of the mesenteron into the "fourth stomach." In some of the specimens examined this was slightly swollen, while in others it appeared as a mere tube. Malouf states that the first, second and third stomachs, according to his terminology, have the same histological structure. He states that "the muscle fibers (as in the stomodeum) are spaced from one another. The circular layer is external to the internal layer." This arrangement is also the opposite to that usually found in the mesenteron of insects. Harris shows the longitudinal muscles external to the circular muscles in *Murgantia histrionica*.

The fourth stomach (Fig. 1, 4TH. S.) or caecal part turns dorsad from the third stomach of Malouf, makes somewhat of a loop and passes into the dorso-posterior region of the "ilium." It is apparently composed of four rows of plate-like structures surrounding a tube. Malouf states that "The lumen formed by the inner faces of the caecal discs is not lined by the epithelium. An inner membrane lines the lumen. Into the extreme posterior portion of the fourth stomach the circular and longitudinal muscles of the rectum extend." Harris states that epithelial cells are present in *Murgantia histrionica*.

Proctodeum—The fourth stomach passes into the "ilium" on the dorso-posterior side.

The "ilium" is a small knob-like structure on the anterior end of the rectum. A pair of rather large Malpighian tubules are inserted on each side of it. The Malpighian tubules are rather long and form an entangled mass in the dorsal part of the body cavity. They lie in the region of the second, third and fourth abdominal segments.

The rectum (Fig. 1, REC.) is a rather large membranous-like organ which extends forward to the posterior part of the third abdominal segment. It becomes narrower in the fifth segment and extends to the anus as a narrow tube.

Salivary Glands—There is a pair of principal salivary glands (Fig. 1, P.S.G.) which lie dorso-lateral to the "crop" of Malouf, one on each side. The anterior lobe is somewhat hand-shaped, having four distinct finger-like projections on the anterior end. The posterior lobe is tubular and may extend posteriorly to the anterior part of the third segment. At the juncture of the two lobes in each gland, there arise the salivary

ducts which extend forward and after passing around the commisure between the sub-oesophageal ganglion and the first thoracic ganglia come to lie beside each other, passing forward and emptying into the ventral side of the salivary pump. In one specimen these tubes, after passing around the commisure, converged and lay parallel to each other for a short distance after which they diverged and led to the principal salivary glands. From each gland just posterior to the salivary duct an accessory salivary gland (Fig. 1, A.S.G.) arises and extends posteriorly and somewhat ventrad reaching almost to the end of the posterior lobe of the principal gland. After folding upon itself several times it turns abruptly anteriorly. It runs forward to the posterior part of the head where it turns posteriorly and enlarges to about twice its size. It makes several convolutions in the anterior part of the prothorax and then runs posteriorly to approximately the juncture of the pro- and mesothorax where about two more convolutions are made, after which it runs more or less as a straight tube to the posterior part of the metathorax.

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FIG. 1. The gross anatomy of the alimentary canal of *Solubea pugnax* (Fab.)

Tectonics

For the past three decades E. B. Bailey has been associated with tectonic research, belonging to the group led by Peach and Horne and Clough. His various works are well known to students of structure, especially those dealing with the Scottish Highlands. It is a pleasure to have before us a series of essays on tectonics. These deal largely with Alpine tectonics. In the twelve chapters the author reviews tectonic discoveries from 1775 to 1893, and then deals with the works of various sarcavts of the Swiss Alps, the Pre-Alps, the Alps of the Rhone sector, the Pennine Alps and the Window of the Hohe Tauern. Many of the various papers of Marcel Bertrand on the structure in Provence are abstracted, and finally there is considered the work of Gavarnie in the Pyrannees.

These essays were started in 1924 and have been completed during the last decade, so that in some of the earlier ones the recent advances in tectonics are not included. Professor Bailey has given us a great mass of information collected from numerous sources, larded with his critical observations, and presented in his condensed and clear style. For the English-speaking student it represents a valuable contribution. Not only does it give the important facts of tectonic researches without necessitating the reading of innumerable French and German articles, but also gives the delightful interpretations of the author. The numerous line cuts and maps are well-chosen and greatly help the understanding of the obscure and difficult points in the structural discussions.—WILLARD BERRY.

Tectonic Essays, Mainly Alpine, by E. B. Bailey. ix+191 pp. New York, The Oxford University Press, 1935.

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VOL. XXXVI JULY, 1936 No. 4

ANNUAL REPORT

OF THE

OHIO ACADEMY OF SCIENCE

Forty-sixth Meeting

1936

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REPORT OF THE FORTY-SIXTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

WILLIAM H. ALEXANDER,
Secretary

INTRODUCTORY

One hundred and seventy-three members registered at the Forty-sixth Annual Meeting of the Ohio Academy of Science held at the University of Toledo, Toledo, Ohio, on April 10 and 11, 1936; forty-one new members were elected and fifteen were raised to the rank of Fellow in the Academy.

There were two short business sessions of the Academy, some twelve or thirteen sectional meetings and a half dozen joint meetings of two or more sections, including the *Ohio Physics Club*, which, according to the custom of the past few years, met with the *Section of Physics and Astronomy*. The tendency toward joint meetings of the sections was quite evident from the printed program and was amply justified by the results, it appears. The general scientific sessions of the Academy were reduced to a minimum—only one. At this one meeting the Academy had the rare privilege of hearing an address abundantly illustrated by lantern slides and movie films on "Endocrine Factors in Sexual Reactions of Amphibia," by Dr. Roberts Rugh, of Hunter College, New York City. The Presidential Address on "*The Concept of Natural Law in Geology*," by President Bucher, was of a higher order and was most favorably received and commented upon.

Another feature of notable value was the "*Symposium on Virus Diseases*" conducted under the auspices of the Sections of Medical Sciences and Zoology. These discussions were led by men of eminent talent and of recognized authority and aroused much enthusiasm and profitable thought and debate.

Aside from the election of officers and committeemen, the items of business of general interest to the Academy transacted at this meeting were, first, the practical approval of the Academy of a recommendation from the Executive Committee to amend the Constitution and By-Laws so as to make the membership committee a *standing committee of the Academy* through which to carry on a continuous membership drive, and second, a decision to fall in line with the newly-adopted policy of the American Association for the Advancement of Science to grant

funds for research only. The Board of Trustees of the Research Fund has been asked to prepare definite instructions for submitting requests for aid in research problems. A third item of interest was the authorizing of the incoming president to appoint a committee of five to take into consideration during the year the matter of a suitable observance four years hence of the fiftieth anniversary of the organization of the Academy and to bring in definite recommendations at the next annual meeting.

MINUTES OF THE BUSINESS SESSIONS

First Session: April 10, 1936

The first business session was called to order by the President at 9:30 A. M. in the Doermann Theater, University of Toledo, with a quorum present. The President announced the appointment of the following special committees:

On Membership—K. G. A. Busch, Eugene Van Cleef, and Samuel Allen.

On Resolutions—Frederick C. Waite.

On Necrology—James P. Porter.

The reports of the Secretary and Treasurer were read, accepted and filed. By vote of the Academy, the Secretary cast a written ballot for the eight current vice-presidents to constitute a nominating committee for 1937.

The report of the Executive Committee was read by the Secretary, formally received and ordered filed.

Upon motion unanimously passed the Secretary was directed to prepare the necessary amendments to the Constitution and By-Laws to make the membership committee permanent and submit same to the next annual meeting of the Academy, this motion to serve as notice of the proposed changes.

Adjourned to meet at 8:30 A. M. tomorrow.

Second Session: April 11, 1936

The adjourned business session was called to order by President Bucher at 8:30 A. M. with a quorum present.

The report of the Trustees of the Research Fund was read by the President in the absence of the Chairman of the Board, Dr. Herbert Osborn. The Trustees expressed the hope that

any member in need of financial assistance in connection with a research problem would not hesitate to let it be known even though the amount available is small.

As usual, the Library Committee, through its chairman, Mrs. Ethel M. Miller, presented an interesting report which was received with enthusiasm and ordered filed with a vote of thanks to Mrs. Miller.

For the Committee on State Parks and Conservation, Mr. E. S. Thomas, its chairman, made a very complete and highly entertaining report which was received with appreciation and ordered filed.

The Secretary then read the report of the Committee on the Election of Fellows as published elsewhere in these Proceedings.

For the Membership Committee Dr. K. G. A. Bush reported having received 41 applications for membership in the Academy and as all were in due form and accompanied by one year's dues the committee recommended their election to full membership. Report received and recommendation approved.

The report of the Joint Administrative Board, Ohio Journal of Science, prepared by C. G. Shatzer and E. L. Rice, was read by Prof. L. H. Snyder, editor of the Journal, formally received and ordered filed.

Dr. A. E. Waller, representative of the Academy on the Save Outdoor Ohio Council, reported for that organization. His report appears elsewhere in these Proceedings.

For the Nominating Committee, Prof. Robert S. McEwen, chairman, made the following report:

For President.......................... CHARLES A. DOAN

For Vice-Presidents—

A.	Zoology	A. W. LINDSEY
B.	Botany	CLAUDE E. O'NEAL
C.	Geology	FRED FOREMAN
D.	Medical Sciences	R. A. KNOUFF
E.	Psychology	GARRY C. MYERS
F.	Physics and Astronomy	G. E. OWEN
G.	Geography	REUEL B. FROST
H.	Chemistry	ALBERT P. MATHEWS

For Secretary.......................... WILLIAM H. ALEXANDER

For Treasurer.......................... A. E. WALLER

For Executive Committee.............. W. H. BUCHER
H. H. M. BOWMAN

For Publications Committee and Administrative Board	E. L. Rice C. G. Shatzer R. V. Bangham
For Board of Trustees	William L. Evans
For Library Committee	W. H. Shideler
For State Parks and Conservation	E. R. Hayhurst Edmund Secrest L. E. Hicks

The report was received and motion duly passed instructing the Secretary to cast the unanimous vote of the Academy for the nominees mentioned.

Following the report of the Nominating Committee, the attention of the Academy was called to the recommendation from the Executive Committee to the effect that some action be taken at this meeting looking toward a suitable observance of the fiftieth anniversary of the founding of the Academy and after some discussion, Dr. F. C. Waite made the following motion:

> "That the incoming President appoint a preliminary committee of five on plans for the celebration and that this committee be charged to make a definite report of plans at the meeting next year."

The Secretary then asked if the Academy wished to select a representative on the Council of the American Association for the Advancement of Science at the Atlantic City meeting next December or to express its wish as to time and place of the next meeting. Upon motion duly passed these matters were referred to the Executive Committee with power but not before Dr. R. V. Bangham, on behalf of the College of Wooster, expressed the hope that the Academy would meet in Wooster next year.

Adjourned at 9:25 A. M.

THE SCIENTIFIC SESSIONS

General and Sectional

The following is a list of the addresses and papers presented at the general and sectional meetings of the Academy as reported to the secretary, viz.:

1. THE PRESIDENTIAL ADDRESS: The Concept of Natural Law in Geology........Walter H. Bucher
2. THE INVITATION ADDRESS: Endocrine Factors in Sexual Reactions of Amphibia........Dr. Roberts Rugh
3. Notes on Ohio Ladybird Beetles (*Coccinellidae*)........William C. Stehr
4. A Useful Method of Labeling Geological and Paleontological Specimens. Mary Auten

5. A Study of Certain Groups of the Genus Thamnotettix, DWIGHT M. DELONG
6. A Study of the Male Genital Characters of the Genus Draeculacephala (Homoptera, Cicadellidae), DWIGHT M. DELONG AND RALPH H. DAVIDSON
7. Initial Temperature Effect upon the Rate of Differentiation of Whitefish Embryos....JOHN W. PRICE
8. Anomalies in Whitefish Embryos Induced by Extreme Temperatures, WALTER M. STOUT
9. The Respiratory Mechanism of *Thyone briareus*....ROBERT A. BUDINGTON
10. Cytological Observations on the Relation Between the Acini and the Islets of Langerhans in the Rat Pancreas....S. D. NEILSEN
11. Barnacles of Hawaii....J. PAUL VISSCHER
12. Responses of Chick Gonads to Gonadotropic Hormones...W. R. BRENEMAN
13. Chromatophore Studies in the Vermillion-spotted Newt, KENNETH L. KELLEY
14. Early Development of the Swim-bladder in *Hemichromis bimaculata*, ROBERT S. MCEWEN
15. A Revision of the Planarian Genus Phagocata....JAMES A. MILLER
16. Reduction of Janus Green in *Limnodrilus Claparedianus*..JAMES A. MILLER
17. Constant Temperature Record of Surface Water in Lake Erie and its Relation to Dissolved Oxygen and Carbon Dioxide, FREDERICK H. KRECKER
18. Seasonal Changes in the Size and Activity of Thyroid Glands in Wild Birds....S. CHARLES KENDEIGH
19. Relationships between Blood Sugar and Torpidity in Certain Hibernating Animals....JOHN M. CONDRIN
20. Activity Rhythms in Goldfish....WILLIAM KIEFFER
21. Experimental Rearing of Whitefish in Ohio State Fish Farms in 1935, T. H. LANGLOIS
22. The Use of Paraldehyde and Benzyl Alcohol Mixture as an Anesthetic for Laboratory Animals....W. R. BRENEMAN AND EDWARD LEDERMAN
23. Merriam's Life Zones and the Distribution of Ohio Orthoptera, EDWARD S. THOMAS
24. Wildlife Sanctuaries Sponsored by the Ohio Academy of Science in Southern Ohio....FLOYD B. CHAPMAN
25. A Suggested Quail Management Program in Ohio, LUTHER L. BAUMGARTNER
26. On Bird Migration "Waves"....LYNDS JONES
27. Returns from Fish Tagged in Ohio....E. L. WICKLIFF
28. Artificial Lakes in Ohio....LEE S. ROACH
29. The Bird Population of a 65 Acre Tract of Beech-Maple Forest Near Cleveland....ARTHUR B. WILLIAMS
30. Low Dams and Their Effect on Stream Conditions....LEE S. ROACH
31. Suggested Modifications for Stream Cleanup Projects....E. L. WICKLIFF
32. Applications of Pollen Analysis in Semi-arid Climates....PAUL B. SEARS
33. Progress of Barberry Eradication in Ohio....HARRY ATWOOD
34. The Pathologic Races of Wheat Stem Rust in Ohio, W. G. STOVER AND HARRY ATWOOD
33. Barberry Seedling Survival at Maumee, Ohio....W. G. STOVER
36. Southern Appalachian Flora in Jackson County....LESLIE L. PONTIUS
37. The Alkaline Raised Bogs of Ohio and Indiana....ROBERT B. GORDON
38. Report on the State Herberium and New Records of Ohio Vascular Plants....JOHN H. SCHAFFNER
39. The Behavior of Chlorophyll in the Green Leaf....ONDESS L. INMAN
40. Methods of Obtaining Evidence of Achievement of Student in Relation to Various Objectives of Botany Teaching....CLARK W. HORTON
41. Somatic Development with Reference to the "Multinucleate Phase" and "Phragmosphere" Formation....R. T. WAREHAM
42. The Status of *Arundo bambos* L....F. A. MCCLURE
43. Conidial Variation in Some Imperfect Fungi....CONST. J. ALEXOPOULOS
44. A Note on Epiphytic Algae on the Roots of an Orchid..H. H. M. BOWMAN
45. Apomixis in Iris....A. E. WALLER
46. Some Structural Changes in Soy Bean Plants Grown from Seeds Irradiated with Soft X-Rays....THEO. P. LONG AND H. KERSTEN
47. Champaign's Guardian of Biological History, (Presented by title). MARGARET B. CHURCH

48. Rare Stylolites.......................................Paris B. Stockdale
49. Portersville Member of the Conemaugh Formation in Muskingum County, Ohio.......................................Wilson M. Laird
50. Some Allegheny Cephalopods from Eastern Ohio...Myron T. Sturgeon
51. *Triarthrus eatoni* in the Eden of Ohio....................Harry J. Klepser
52. Some Aspects of Acidizing Oil Wells......................P. E. Fitsgerald
53. Outline of the Section of Geology Spring Field Trip.....Grace A. Stewart
54. Some Geological Relationships of the Soils of Great Britain, G. W. Conrey
55. Silting in the Muskingum College Lake...................G. Robert Hall
56. Observation of Wave Action along the Shores of Lake Erie, William H. Gould
57. The Glacial Beaches in Lucas County..................J. Ernest Carman
58. A Reclassification of the Paleozoic Systems of Michigan....G. M. Ehlers
59. Some Economic Aspects of Chert in Mineral Aggregates, Herbert F. Kriege
60. Lewis Hills Overthrust, Western Newfoundland..........John R. Cooper
61. A Preliminary Report on the Igneous Intrusions in the Vicinity of Monterey and Hightown, Highland County, Virginia.....Fred Foreman
62. Permian-Carboniferous Boundary in Ohio..................Willard Berry
63. Foundation Exploration for the Muskingum Watershed Conservancy Dams.......................................Henry G. Martin

SYMPOSIUM ON VIRUS DISEASES

64. The Nature of Viruses with Special Reference to Plant Viruses, by Jorgen M. Birkeland, Ph. D., Assistant Professor of Bacteriology, Department of Bacteriology, Ohio State University.
65. The Use of the Foetus as an Experimental Animal for Virus Studies, by Oram C. Woolpert, Ph. D., M. D., Assistant Professor of Bacteriology, Department of Bacteriology, Ohio State University.
66. The Cultivation of, and Immunological and Clinical Studies with, the Virus of Lymphogranuloma Inguinale, by Joseph T. Tamura, Ph. D., Department of Bacteriology and Hygiene, University of Cincinnati.
67. Factors of Resistance and Immunity in Poliomyelitis, by N. Paul Hudson, Ph. D., M. D., Professor and Chairman of the Department of Bacteriology, Ohio State University, Edwin H. Lennette and Francis B. Gordon, Department of Hygiene and Bacteriology, University of Chicago.
68. Epidemiologic Considerations in the Field of Virus Diseases with Special Reference to the Common Cold and Influenza, by J. A. Doull, M. D., D. P. H., Professor and Director of the Department of Hygiene and Public Health, Western Reserve University School of Medicine.
69. Locating the Basal Age on the Stanford Revision of the Binet-Simon Scale by Means of the Vocabulary Test..................W. E. McClure
70. The Effect of Point of View in a Ranking Test..................J. J. Smith
71. The Relation of Length of Material and Other Factors to Exposure Time in the Perception and Memory for Visual Forms, William C. Schwarzbek
72. Further Study of the Childhood Environmental Determinants of Adolescent Personality..................................Ross Stagner
73. Abuse of the Genetic Viewpoint...........................H. B. English
74. An Attempt to Measure the Effectiveness of White Space in an Advertisement on the Basis of Actual Sales........................Melvin Riggs
75. Effect of Various Incentive Conditions on Work Out-put.....J. S. Kounin
76. The Breakdown of a Discrimination Habit and Its Bearing upon Reminiscence.......................................Amos C. Anderson
77. The Influence of the Figure-Ground Relation in Memorizing Visual Forms...Otis D. Knight
78. Brain Potentials in Children and Adults................Donald B. Lindsey
79. A New Approach to the Study of Traffic Behavior.............S. E. Haven
80. A New Type of Timing Apparatus and its Application in the Training of Runners.............................S. M. Howarth and B. M. Davis
81. The Influence of Note-taking upon the Comprehension of Certain Textbook Materials.......................................C. D. Matthews
82. Age Differences in Productivity: "Best Books"..............H. C. Lehman
83. Size Constancy in Visual Objects.....................Beverly E. Holiday

84. Sources of Moral Judgments of Under-Privileged Children, GORDON HENDRICKSON
85. A Critical Evaluation of Some Class-Room Learning Problems, GARRY C. MEYERS
86. Identification of Harmonics at Radio Frequencies........... RICHARD HOWE
87. Interpretation of Star Counts in Obscure Regions...... FREEMAN D. MILLER
88. Absorption Spectra of Some of the Simpler Porphyrins, V. M. ALBERS AND H. V. KNORR
89. Electrical Contact.. T. H. OSGOOD
90. Further Studies with Negative Hydrogen Ions, PAUL F. DARBY AND WILLARD H. BENNETT
91. Sharpness and Speed of Photographic Lenses, J. A. BING AND C. O. DELUNG
92. The Ultra-Violet Absorption Spectrum of Nitrogen.......... J. J. HOPEFIELD
93. Time Measurements on Photographic Shutters... L. E. KOESTER AND I. SEFF
94. Study of Electrolytic Dissociation of $KHSO_4$ by Raman Effect. DONALD M. CAMERON AND WAVE H. SHAFFER

JOINT MEETING WITH OHIO PHYSICS CLUB AND CHEMISTRY SECTION

95. Internal vs. External Symmetry in Crystals.................... F. C. BLAKE
96. Fluorescence and Photo-decomposition of Chlorophyll *a* and *b* under Atmospheres of O_2, CO_2 and N_2.......... H. V. KNORR AND V. M. ALBERS
97. Some Remarks on Waves and Corpuscles.......................... A. LANDE
98. A System of Isotopes.. HAROLD B. LAW
99. The Nature of the Metallic State.................... W. CONRAD FERNELIUS
100. Some Properties of Deuterium Oxide.................. JOHN S. RICHARDSON
101. Artificial Radioactivity............................ HERRICK JOHNSTON

JOINT EDUCATIONAL PROGRAM WITH OHIO PHYSICS CLUB AND CHEMISTRY SECTION

102. Projects in Chemistry III. Projects in the Teaching of Chemistry Course.. K. G. BUSCH
103. Series and Parallel Resonance Circuit for Lecture............... RAY LLOYD
104. Comparison of Vacuum Tubes for Use as Direct Current Amplifiers, GEO. H. GABUS
105. Stimulation of Student Interest in Physics.................. JOHN MESCHER
106. Discovering Laws in the Elementary Laboratory............. H. P. KNAUSS
107. Laboratory Apparatus...................................... DON SMITH
108. Two Simple Classroom Experiments..................... JOHN P. KARBLER
109. New Free Fall Apparatus.................................. NOLAN BEST
110. The Luminosity of Stars of High Axial Rotation............... J. A. HYNEK
111. X-Ray Energy Levels..................................... S. J. M. ALLEN
112. Aerial Phytography and Map Revision............... MAJOR FRED L. SMITH
113. The Westerville, Ohio, Area: An Interpretation of Field Data, JOHN H. GARLAND
114. The Functional Pattern of Barberton, an Industrial Suburb of Akron, Ohio.. JAMES R. BECK
115. The Evaluation of Soil Deterioration and Improvement in a Land Use Program.. G. W. CONREY
116. Geographic Aspects of Coal Cargoes from Toledo........ WALTER G. LEZIUS
117. Finnish Population Movement in Ohio.................. EUGENE VAN CLEEF
118. Physical Influences on Economic Pressures in Ohio.... KYLE W. ARMSTRONG
119. Physical Factors Affecting Land Use in Central Massachusetts, GUILBERT R. GRAHAM
120. The Resettlement Project of the Matanuska Valley in 1935, C. C. HUNTINGTON
121. Schott's Natural Regions of the Oceans: A Review..... PRESTON E. JAMES
122. The Delusion of the Colonial Argument.................. W. R. MCCONNELL
123. Can Germany be Self-sufficient?........................ CLARENCE HESKETT
124. Early Geographic Adjustments in the Wellington Settlement, New Zealand.. WILFRED G. RICHARDS
125. Recent Trends in the Foreign Trade of Japan........ DANIEL R. BERGSMARK

126. The Precipitation of Barium Sulfate in Alkaline Solutions, CLYDE A. HUTCHISON AND H. V. MOYER
127. The Determination of Atmospheric Pollution. A Demonstration, PHILIP R. FEHLANDT
128. Gasoline Explosion Investigation, ALBERT R. MORRISON AND JAMES R. WITHROW
129. New Synthetic Porphyrins................................PAUL ROTHEMUND
130. Thermodynamic Investigation of Flash Evaporation of Potassium Sulphate Liquors from Polyhalite. Accuracy of International Critical Tables Data on Heat of Formation of Potassium Sulphate Solutions, JOSEPH PATRICK CREAGH AND JAMES R. WITHROW
131. The Value of Chemistry in Determining the Mineral Constituents of Our Common Rocks.......................................WILBER STOUT

JOINT MEETING WITH THE SECTION OF PHYSICS AND ASTRONOMY AND THE OHIO PHYSICS CLUB

132. Joint Education Program with Section of Physics and Astronomy and the Ohio Physics Club.
133. Trip of Inspection by the Chemistry Section to the Owens-Illinois Glass Research Laboratory.
134. This recently built laboratory is made entirely of glass blocks, is insulated with glass wool, and has no windows. This trip should be of great interest to all chemists and also others interested in science.

REPORTS

Report of the Secretary

TOLEDO, OHIO, April 10, 1936.

To the Ohio Academy of Science:

The general duties of a secretary are well known and therefore need not be reviewed at this time. Details too numerous to mention, a rehearsal of which would be inexcusably tedious and might even "bore you to extinction;" we will therefore content ourselves with a few high spots, reserving for ourselves the Congressional privilege of extending our remarks for the record!

The secretary's work does not end with the adjournment of the annual meeting; the proceedings must be prepared for filing and publication; newly elected members, fellows and officers must be notified, and a suitable report for publication in *Science* must be prepared. All these things we did to the best of our ability and as promptly as possible. See *Science* of May 27, 1935.

We represented the Academy as best we could on the Council of the American Association for the Advancement of Science at St. Louis, Mo., last December; also at the Academy Conference, being elected and now serving as the President of this latter organization. We secured for the Academy a cash allowance of $124.00 for the year 1935, on the ground that the Academy was not in a position to avail itself of the grant for research owing to the short notice of the change in policy on the part of the A. A. A. S.

As chairman of the program committee we have co-operated cheerfully and most delightfully with the vice-presidents in the collection of the program material and the making of the program which you have in your possession. The results of the committee's effort speak for themselves. We have also co-operated in an effort to secure new members for the Academy and we wish once again to emphasize this very essential matter. The old stand-bys are leaving us; recruits must be secured!

And now for about the thirteenth time, your secretary wishes to record his very high appreciation of the fine co-operation he has had from the members and officers of the Academy in his efforts to discharge the duties of his office: the associations have been delightful and the memory of these will be fragrant in the months and years to come. This is our greatest reward!

Respectfully submitted,

WILLIAM H. ALEXANDER,
Secretary.

Report accepted and ordered filed.

Report of the Treasurer

RECEIPTS

Cash on hand, January 1, 1935		$ 594.64
Receipts from the Sale of Publications	$ 55.60	
Received from A. A. A. S.	124.00	
Interest on Bonds	479.76	
Dues from Members, Back Dues Collected	503.50	
Total Receipts		1,237.27
Total		$1,831.91

DISBURSEMENTS

Expense to Executive Committee Meetings	$ 7.80
Spahr & Glenn Co., Printers	101.71
Ohio Journal of Science	1,230.01
Membership, Save Out Door Ohio Council	8.00
Postage for Secretary's and Treasurer's Office	22.50
Clerical Help, Secretary's and Treasurer's Office	77.71
Expenses of Vice-Presidents	35.81
Safety Deposit Box	3.30
Program, Committee Meeting, Expenses	12.63
Secretary's Honorarium	100.00
Flowers for 1935 Annual Dinner	2.00
Tickets for 1935 Annual Dinner	2.32
Stenographic Report of 1935 Business Meeting	10.40
Auditing 1934 Report	17.50
Returned Check and Bank Charges	4.63
Total Disbursements	$1,636.32

Total Receipts	$1,831.91
Total Disbursements	1,636.32
Balance	$ 195.59

Respectfully submitted,

A. E. WALLER,
Treasurer.

Report of Auditor

To the Ohio Academy of Science:

I have audited the report of the Treasurer of the Ohio Academy of Science for the year 1935–36 and have found the following statements to be true:

Cash on hand, January 1, 1935	$ 594.64
Add: Receipts for the year 1935–36	1,237.27
	$1,831.91
Less: Disbursements for the year 1935–36	1,636.32
Cash Balance, January 16, 1936	$ 195.59
Balance in Huntington National Bank, January 16, 1936	$ 195.59
Less: Outstanding Checks	(None)
Cash Balance, January 16, 1936	$ 195.59

OHIO ACADEMY OF SCIENCE BALANCE SHEET

As of January 16, 1936

Assets

Current Assets:	
Cash	$ 195.59
Bonds—3% Cons. Federal Land Bank (listed at purchase price)	1,290.25
Research Fund (Schedule I)	1,923.27
	$3,409.11

Liabilities and Net Worth

Net Worth:	
Surplus	$3,409.11

Research Fund

Schedule I.	
Cash Balance, January 1, 1935	$ 200.40
Add: Receipts for Year 1935–36 (Dividends and Interest)	86.25
	$ 286.65
Less: Disbursements for year 1935–36. Lorain Urban Survey and Bank Charges	100.88
Cash Balance, January 1, 1935	$ 185.77
Bank Balance, January 1, 1935	$ 185.77
Less: Outstanding Checks	(None)
Balance, January 1, 1935	$ 185.77
Cash Balance	$ 185.77
Bonds, 5% (listed as at purchase price)	1,300.00
BancOhio Stock, 25 shares	437.50
Total Research Fund	$1,923.27

I certify that the above statements are, in my opinion, true and correct and correctly set forth the results of the operations of the Ohio Academy of Science for the year January 1, 1935, to January 1, 1936.

Respectfully submitted,

Delber Kinsel,
Fraternity Auditor.

Report of the Trustees of the Research Fund

December 19, 1936.

Mr. W. H. Alexander, Secretary,
Ohio Academy of Science.

DEAR MR. ALEXANDER:—I submit herewith statement of the Academy Research Fund as of present date and, as there are no commitments or anticipated changes before the end of the month, present the account for the annual audit in this form. As I expect to leave Columbus before the end of the year and as I may not be in attendance at the spring meeting of the Academy this account may be submitted as the annual report, although I may wish to make an additional statement at that time.

SUMMARY OF CREDITS

Balance in Checking Account January 1, 1935	$200.40
Receipts from Interest and Dividend Payments	86.25
Total	$286.65

DISBURSEMENTS

Grant to R. B. Frost toward Lorain Urban Survey	$100.00
Service Charges, Ohio National Bank	.88
Balance in Checking Account, Ohio National Bank	185.77
Total	$286.65

STATEMENT OF INVESTED ASSETS

Bonds (listed as at purchase price), 5% Income	$1,300.00
25 Shares BancOhio Stock (listed at purchase price)	437.50
Total	$1,737.50

Receipts from our bonds are now at the rate of 5% and the latest information I have is that the BancOhio stock is quoted at above the price we paid and we receive quarterly dividends regularly.

Our securities are deposited for safe keeping and the checking account is carried by the Ohio National Bank, 167 South High Street, Columbus, where confirmation of these figures may be obtained for the audit. Mr. Kenneth T. Whitaker, who has looked after the Academy finances since Dr. Mendenhall was in charge of the Research Funds, may be consulted for ready attention to audit enquiries.

Respectfully submitted,

HERBERT OSBORN,
Chairman, Research Fund.

NOTE.—If you will give your auditor a note certifying his authority to examine the deposits at Ohio National Bank, I am sure he will find ready attention.

H. O.

Report of the Executive Committee

(By the Secretary)

TOLEDO, OHIO, April 10, 1936.

To the Ohio Academy of Science:

The Executive Committee held three meetings during the year with all members present: One on December 7, 1935, one on January 18, 1936, and the third, last evening at the Secor Hotel in Toledo, Ohio. At the first meeting, there were present by invitation Dr. Herbert Osborn, chairman of the board of trustees of the Research Fund; Dr. E. N. Transeau, representing the Ohio State University on the Administrative Board, Ohio Journal of Science; Dr. L. H. Snyder, editor of the Ohio Journal of Science; and Dr. B. S. Meyer, business manager of the Ohio Journal of Science.

The primary purpose of this meeting was to consider certain financial matters in connection with the Ohio Journal of Science. After a full, frank statement of facts by the four gentlemen mentioned and after ample, free and frank discussion by the Committee, it appearing that a real crisis had developed in the financial affairs of the Ohio Journal of Science, the following motion was unanimously passed by the Executive Committee, viz.:

> "That the Treasurer be authorized and directed to pay out of the reserve fund the sum of $700.00 into the fund of the Ohio Journal of Science, $450.00 of this amount to meet bills now due and $250.00 to pay for the next issue of the Journal."

The Treasurer reported a reserve fund of some $1,700.00. He was instructed by the Committee to invest the balance in U. S. Treasury Certificates.

At this meeting it was unanimously decided to accept the invitation of the University of Toledo to hold the 46th annual meeting within its walls.

The question of inviting the Michigan Academy of Science to meet with the Ohio Academy at Toledo was considered favorably and the Secretary was asked to look into the feasibility of such a joint meeting, if not this year, then next.

The Secretary was selected to represent the Academy on the Council of the American Association for the Advancement of Science and at the Academy Conference of the A. A. A. S.

At the second meeting the Secretary made a partial report of his actions as representative of the Academy at the St. Louis meeting of the A. A. A. S., the chief item being the securing of a cash allowance of $124.00 instead of funds for research only. The Secretary was elected President of the Academy Conference.

In view of this rather fundamental change in the financial arrangements between the Association and the Academy the Committee felt that action should be taken to advise the membership, especially those thinking of making application for research funds, that all such applications must be in the hands of the Secretary or Chairman of the Board of Trustees not later than the annual meeting of the year in which the

solicited funds are to be used. A suitable form on which to make application for said funds is to be prepared indicating in a general way the information desired by the Academy from those applying for the funds.

The matter of delinquent dues was freely though sympathetically discussed, the discussion culminating in a request that the Treasurer send a tactful letter at once to all delinquents requesting them to indicate their wishes or intentions regarding back dues, assuring them of the Academy's willingness to accept any reasonable adjustment of same.

The question of a membership campaign was raised and the committee went on record as favorable to same and to this end it was suggested that provision be made in the Constitution or By-Laws for a standing membership committee.

A third meeting was held last evening at the New Secor Hotel, Toledo, Ohio, with all members present except the President, who was not feeling well and asked to be excused. As the result of the deliberations at this third meeting the following recommendations are made to the Academy:

1. That the necessary changes be made in the Constitution and By-Laws to provide for a permanent committee on membership.

2. That action be inaugurated at this meeting looking toward a suitable observance of the Fiftieth Anniversary of the organization of the Academy four years hence and to this end the committee suggests the appointment of a special committee of ways and means, committees, etc., to make report with recommendations at the next annual meeting of the Academy.

3. That the Board of Trustees be asked to prepare a suitable form for use in applying for research funds.

Respectfully submitted,

WILLIAM H. ALEXANDER,
Secretary.

Report accepted and ordered filed.

Report of the Library Committee

COLUMBUS, OHIO, April 10, 1936.

To the Ohio Academy of Science:

The report of the chairman of this committee for last year stated that a systematic check was then being made upon the exchanges to ascertain whether they were being received regularly at the Ohio State University library, as it had been several years since this had been done, but that no report could be given at that time. The results were just what one would expect. Most of the exchanges are coming regularly; a few had taken the name of the University Library off their mailing lists but were willing to replace it when the matter was called to their attention, and some were such that it seemed desirable for one reason or another to drop them from our mailing list. One name was transferred from the subscription list of the Ohio Journal of Science to the

exchange list as this organization has presented valuable bound books and serials to the Ohio Academy of Science for years but yet has been purchasing its copy of the Ohio Journal of Science. Fourteen exchanges were dropped and seven new ones secured. The number is now 375. As many of them send more than one title on exchange the number of periodicals and serials which are received in this way is between five and six hundred with a value of a thousand to twelve hundred dollars.

Routine work has been carried on as usual, such as claiming exchanges that failed to arrive at the proper time, changing addresses on the mailing list, adding new names and removing a few. A little more reference work than usual has been done at the request of a few of the Ohio Academy of Science members. The chairman of this library committee is very glad to be called upon for such library work as it is possible for her to do. No guarantee is made that the results will be entirely successful but the assurance is given that every possible effort will be made to secure the desired information.

The sales of publications amounted to $50.05, which was a substantial increase over the sum of $32.30 for the preceding year. The number of sales for each year remained the same, twenty-six, but the number of papers sold increased from 50 in 1934 to 88 in 1935. One sale of a complete set of the forty Annual Reports and all but five of the twenty-one Special Papers, amounting to $23.70, made a good addition to the total sales. This set was purchased by Kent State College last April. Another nearly complete set was purchased this year by the Toledo Public Library. This made a good beginning for the 1936 sales and its amount of $26.30 will appear in next year's report. Only four sales were made to places outside of our own state.

The "Batrachians and Reptiles of Ohio" gained first place in popularity this year with the "Fishes of Ohio" next. The two papers which tied for first place last year fell to fourth place this year, showing how variable the demand is from year to year.

During the year the sum of $55.60 has been given to the Treasurer of the Academy. This included a balance of $6.05 on the 1934 sales and $49.55 on the sales for 1935. One bill for fifty cents is still outstanding. A paper was sold to a certain department of the Ohio State University and it will unquestionably be paid for when the unusual financial conditions now existing at the University are remedied.

The sum of $30.09 still remains in the name of the Ohio Academy of Science in the Buckeye State Building and Loan Company. This could be withdrawn as the company is now paying on stock accounts at the rate of twenty-five dollars a month, but as it was not drawn out before the first of the year it does not appear on the Treasurer's report.

Continuing the policy of last year no formal financial statement is being given in this report, but it has been duly made and is on file for the purpose of record.

Respectfully submitted,

ETHEL MELSHEIMER MILLER,
Chairman.

Report of the Joint Administrative Board of the Ohio Journal of Science

COLUMBUS, OHIO, April 10, 1936.

To the Ohio Academy of Science:

A meeting of the Joint Administrative Board was called together at 4:15 P. M. on November 16, 1935, by Chairman Rice. Present were all members of the Administrative Board, the Editor and the Business Manager of the Journal. The Business Manager presented a statement of the present financial situation of the Journal which was followed by a prolonged discussion by members of the Board.

Motion carried that the Administrative Board of the Journal approach the Executive Committee of the Ohio Academy of Science, explain to them the present financial difficulty of the Journal and request (1) payment of the Journal's share of the Ohio Academy of Science dues for the current year to date, drawing if necessary upon the reserve fund of the Academy for this payment, and (2) advance $250.00 of the 1936 payment of the Academy in order to help defray cost of publishing the November issue of the Journal and thus avoid the present deficit in the Journal's funds due to a delay in the payment of the second half of the 1935 University grant to the Journal resulting from the Governor's vetoes.

The meeting adjourned at 5:15 P. M.

A second meeting was held on April 10, 1936. Present were Messrs. Rice, Transeau, Shatzer and Snyder. Chairman Rice presided. The Business Manager's report was presented, as follows:

THE OHIO JOURNAL OF SCIENCE

FISCAL YEAR 1935

RECEIPTS

Balance from 1934	$ 317.32
University Grant	375.00
Ohio Academy of Science	600.00
Ohio Academy of Science—Proceedings, 1935	143.55
Ohio Academy of Science Research Fund (for paper by R. B. Frost)	100.00
R. B. Frost, for Printing Special Paper	75.00
Ohio State Chapter Sigma Xi—Symposium Number	266.81
Subscriptions	85.25
Sale of Individual Copies and Volumes	67.50
Authors Payments for Plates and Publication Out of Order	80.46
	$2,110.89

EXPENDITURES

Spahr & Glenn Co., First Five Numbers, Volume 35	$1,377.52
Bucher Engraving Co	448.90
Postal Charges	122.41
Envelopes	32.50
Clerical Assistance	10.60
Refund on Subscription	2.00
Bank Charges	1.23
	$1,995.16
Balance on hand February 29, 1935, Huntington National Bank	115.73
	$2,110.89

As of present date the bill for the November, 1935, number of the Journal, amounting to $212.90, is still unpaid. All other 1935 bills are paid.

The report was accepted and placed on file. The present financial status of the Journal resulting from the Governor's vetoes was discussed. Since it appeared that the University payments would eventually be made, a motion prevailed that the Journal continue normal publication for the time being, at least.

Respectfully submitted,

B. S. MEYER, *Secretary*,
Joint Administrative Board of the Ohio Journal of Science.

Report of the Save Outdoor Ohio Committee

COLUMBUS, OHIO, April 11, 1936.

To the Ohio Academy of Science:

The reorganization of the Save Outdoor Ohio Council was completed in time to align its activity with the present interest in conservation which both State and Federal Government agencies are showing. The new attitude toward conservation on government's part may be said to be widespread rather than deep. If this public vaccination with conservation is to take, public education in biology applied to human affairs is needed and badly needed. For it is plain that since conservation means different things to different men, the expenditures of enormous sums have often been at cross purposes. For example, stream clean up, a W. P. A. project, for which the Federal Government allotted one million, eight hundred thousand dollars, was quickly shown to be destructive to plant and animal life along the banks and to the plants and animals of the stream. Even worse, it is a contributing factor to water erosion in flood periods. With the advice of members of the Save Outdoor Ohio Council and the State Conservation Division the program was somewhat improved. It was not stopped entirely, of course. However, the great point was gained that the advice of the Conservation Division was given some consideration.

The plan of beginning education in conservation early is being forwarded by the Save Outdoor Ohio Council and the Division of Conservation. Just how far this will go cannot be predicted. The use of any material is optional with the schools. However, there is available from W. P. A. funds forty-six thousand dollars for materials to schools, scout troops, clubs, etc. It might be suggested that here is a chance for the members of the Ohio Academy of Science to co-operate more fully with the Save Outdoor Ohio Council and to see that really conservative practices are discussed. There has been a total reversal of judgment with respect to "vermin" which included some of the hawks and other predatory birds. There is probably a better appraisal of "weeds" which may include plant life suited to stop the erosion of top-soil layers.

The success of the Save Outdoor Ohio Council in an advisory

capacity is purely to be what we make of it. The more co-operation that is offered the better it will work. A meeting held November 22, 1935, giving an opportunity to hear a number of papers on different aspects of conservation was well attended and well received.

We have continued and expect to continue our membership in the Council. This entitles us as a committee to one vote in the Council. Actually our co-operation is much closer, as many Academy members are active in the Council as an examination of the above list of speakers serves to show.

Respectfully submitted,

A. E. WALLER,
Representative.

Report of Committee on Election of Fellows

COLUMBUS, OHIO, April 11, 1936.

To the Ohio Academy of Science:

The following members were elected to Fellowship in the Academy:

CLYDE STEWART ADAMS
DONALD JOYCE BORROR
RICHARD BRADFIELD
KARL G. A. BUSCH
W. STORRS COLE
RALPH HOWARD DAVIDSON
WILLIS CONARD FERNELIUS
MARGARET FULFORD
JESSE R. HARROD
EDWIN ELMORE JACOBS
JOSEF NISSLEY KNULL
WILLIAM A. MANUEL
JOHN ALDEN MILLER
NICHOLAS MOGENDORFF
PAUL W. K. ROTHEMUND

Respectfully submitted,

W. H. ALEXANDER,
Secretary.

Report of the Trustees of the Research Fund

April 11, 1936.

To the Ohio Academy of Science:

During the past year your trustees have allowed one grant of one hundred dollars and the additions as of December 31st were $85.25, which left in checking account $185.77, which with additions since audit will allow something over $200.00 available for grants or investment. The following summary shows the condition of the fund at January 1, 1936.

RECEIPTS	
Balance in Checking Account, January 1, 1935	$200.40
Receipts from Interest and Dividend Payments	86.25
Total	$286.65
DISBURSEMENTS	
Grant to R. B. Frost toward Lorain Urban Survey	$100.00
Service Charge, Ohio National Bank	.88
Balance in Checking Account, Ohio National Bank	185.77
Total	$286.65

STATEMENT OF INVESTED ASSETS

Bonds (listed at purchase price)	$1,300.00
25 Shares BancOhio Stock (at cost)	437.50
Total	$1,737.50

In case the plan of the A. A. A. S. to have its grant to the Academy available for research projects it will be desirable to have approved projects in view and your Trustees will welcome suggestions. Also additions to the Research Fund from any source will be most welcome as we feel that there will be ample opportunity to use the fund to advantage.

Respectfully submitted,

GEO. D. HUBBARD,
ALPHEUS W. SMITH,
HERBERT OSBORN, Chairman,
Trustees.

Report of the Committee on Necrology

April 11, 1936.

To the Ohio Academy of Science:

Your committee notes with regret the loss of the following members since the last annual meeting:

JANE M. DOREN, Columbus; joined the Academy in 1909, died in 1935 or 1936.

W. H. AIKEN, Cincinnati; joined the Academy in 1898, died October 31, 1935.

WILLIAM C. WERNER, Painesville; a charter member, joined in 1891, made a fellow in 1922, died 1935 or 1936.

THOMAS A. BONSER, Spokane, Wash.; member of the Ohio Academy of Science from 1896 to 1909, when he moved to Spokane; died August 4, 1935; native of Dayton, Ohio.

MRS. KATHARINE D. SHARP, London; joined the Academy in 1911, made a fellow in 1928; died September 19, 1935.

JOHN U. LLOYD, Cincinnati; charter member; made a fellow in 1920; died April 9, 1936, within ten days of being 87 years old.

Respectfully submitted,

JAMES P. PORTER,
Committee.

(Upon motion, the reading of the report carried with it a proper recognition of the work of these members.)

Report of the Membership Committee

April 11, 1936.

To the Ohio Academy of Science:

Your Committee on Membership has received and examined the following applications for membership in the Academy, found same in due form, dues for one year paid, and now recommend their election to full membership in the Academy, viz.:

1. ALBRIGHT, JOHN G., (F), 1906 E. 105th St., Cleveland.
2. ALEXOPOULOS, CONSTANTINE J., (B), Kent State University, Kent.
3. ANDERSON, AMOS C., (E), 137 N. Congress St., Athens.
4. BARR, DR. DANIEL R., (D), Grand Rapids, Ohio.
5. BAUMAN, HARRY, (A), 1091 Jefferson Ave., Akron.
6. BAYFIELD, E. G., (H), Ohio Agr. Exper. Sta., Wooster.
7. BERGSMARK, DANIEL R., (G), University of Cincinnati, Cincinnati.
8. BOND, CLYDE H., (G), R. F. D. No. 3, Quaker City.
9. BRILL, H. C. (H), Miami University, Oxford.
10. BUSCH, DANIEL A., (C), 2424 Sherwood Rd., Columbus.
11. DAVIDSON, HORACE B., (D), Hamilton Hall, O. S. U., Columbus.
12. DENO, RICHARD A., (A), State University, Bowling Green.
13. EBAUGH, DR. W. C., (H), Denison University, Granville.
14. EHLERS, G. M., (C), University of Michigan, Ann Arbor, Mich.
15. GOSLIN, CHARLES R., (B), Lancaster.
16. HARROD, J. R., (H), 115 S. Johnson St., Ada.
17. HENDRICKSON, GORDON, (E), University of Cincinnati, Cincinnati.
18. HOPKINS, EVERETT H., (E), 711 N. Fountain Ave., Springfield.
19. HOROWITZ, MARTIN M. (A), 650 Carpenter St., Columbus.
20. JONES, DR. EDGAR P., (A), University of Akron, Akron.
21. KELLACKEY, SISTER M. CELINE, (B), 2035 E. 79th St., Cleveland.
22. KELLEY, KENNETH L., (A), Kent State University, Kent.
23. LAMEY, CARL A., (C), Dept. of Geol., O. S. U., Columbus.
24. LANGLOIS, THOMAS H., (A), 3448 N. Broadway Place, Columbus.
25. LAWSON, CHESTER A., (A), Wittenberg College, Springfield.
26. PAPPENHAGEN, LOUIS A., (H), 705 W. State St., Alliance.
27. PARK, ORLANDO, (A), Northwestern University, Evanston, Ill.
28. RICHARDS, WILFRED G., (G), 337 Maple St., Oxford.
29. ROTHERMEL, MISS JULIA E., (A), Western College, Oxford.
30. SCHAEFER, PAUL E., (A), Dept. Z. and Ent., O. S. U., Columbus.
31. SCHOTT, RALPH G., (D), B. & Z. Bldg., O. S. U., Columbus.
32. SETON, SISTER ELIZABETH, (A), College of Mt. St. Joseph, Mt. St. Joseph.
33. SHADE, ERVIN H., (H), 681 Girard Ave., Marion.
34. SHANKS, ROYAL E., (B), North Bloomfield, Ohio.
35. SPANDEAU, H. M., (A and B), 97 Sherman Ave., Mansfield.
36. STRETE, RALPH F., (C), Miami University, Oxford.
37. VEEDER, MARTHA ANNA (H), Western College, Oxford.
38. WATT, LUCY J., (A, B and D), Western College, Oxford.
39. WILLIAMS, ARTHUR B., (A), 2717 Euclid Ave., Cleveland.
40. YUNCK, GEORGE F., (C), 706 Central Ave., Sandusky.
41. ZIMPFER, PAUL, (B), 1553 Moler Rd., Columbus.

Respectfully submitted,

K. G. A. BUSH, Chairman,
EUGENE VAN CLEEF,
SAMUEL ALLEN,
Committee.

NOTE: Letter in parenthesis after name indicates section of major interest.

Report of the Committee on Resolutions

April 11, 1936.

To the Ohio Academy of Science:

The Ohio Academy of Science wishes formally to express, for itself as an organization and for each of its members individually, appreciation to the authorities of the University of Toledo for the use of rooms and equipment in the conduct of meetings, and for the courtesies of its staff.

We desire to commend the accomplishments of the local committee which has provided excellent facilities for all our meetings and satisfactory arrangements for the personal comfort of visiting members at the 46th meeting.

F. C. WAITE,
Committee.

PRESIDENTIAL ADDRESS

THE CONCEPT OF NATURAL LAW IN GEOLOGY[1]

WALTER H. BUCHER,
University of Cincinnati

Geology operates largely without the concept of "natural law." The speaker became keenly aware of this circumstance when, a number of years ago, he began his efforts to derive from rapidly accumulating knowledge concerning the geology of different parts of the earth generalizations designed to form a reliable foundation for reasoning concerning the dynamics of the earth's crust.[2] When he spoke of them as "laws of crustal deformation," he had to meet the objections of others and his own doubts. He had to view the procedure of geologic investigations in the light of the fundamental method of all science.

Some of the resulting reflections are presented here before men from many fields of science in the hope that they will lead to a clearer understanding of the nature of the geologist's work, and to that finer sympathy from which springs effective co-operation between men in different sciences upon which further progress depends in a large measure.

Geology is peculiarly dual in its aims: on the one hand it is concerned with what happened *once* at a *certain place*, in *individual* mines, mountains, regions. Interest that centers on individuals is *history*, not science.[3] As a *science*, geology is concerned with the *typical* that finds expression in *generalizations*, whether they be called laws or something else. In his actual work, the geologist described the individual and attempts to grasp its meaning in terms of the typical. If you catch him unawares, he will tell you that he tries to "explain" the "facts" of geology in terms of the "laws of physics and chemistry." But the matter is actually much more complex.

For the purposes of the following discussion, we will do well to remind ourselves first of the essence of all scientific investigation and of the structure of science at large which results from it. Then we shall look at the scientific aspect of the geologist's work and the role which the concept of natural law plays in it.

Fairfield Osborn liked to tell the story "of the little redheaded fellow he accosted in the elevator one day. "Well, my boy," said Professor Osborn, "what do you like best in the museum?" The little tot, in sepulchral voice, answered "fossils."[4] No doubt the circumstances justified the comic effect this answer produced. Yet the story sounds the funnier the less one knows about the mystery that attends the birth of a scientific career in a young mind. Every experienced worker knows of instances of children fascinated, without rhyme or reason, by

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[1]Presidential address read before the Ohio Academy of Science, at Toledo, on April 10, 1936. In the reading pages 191 to 192 were omitted. A number of minor changes have been made in the final manuscript.

[2]Walter H. Bucher, "The Deformation of the Earth's Crust. An Inductive Approach to the Problems of Diastrophism." Princeton University Press, 1933.

[3]Heinrich Rickert, "Die Grenzen der naturwissen schaftlichen Begriffsbildung," Tubingen, 1929, esp. pp. 217–237.

[4]Told by F. T. Davidson, president of the American Museum of Natural History. "Natural History," Vol. 37, 1936.

a group of objects in a museum. They come back with longing eyes and at last overcome their shyness and ask questions. They want to know.

What is it they want to know? Generally, above all, what things are called—names. Few aspects of science amuse the layman more than what he considers the child-like delight scientists take in cryptic, if not bombastic, nomenclature. There are not a few men of science, in fields less encumbered by verbiage, who are inclined to share this sentiment.

Those who are closer to the realities of the descriptive sciences know better. The plain fact is that apart from troublesome taxonomic tangles every scientific name is a code word for a group of natural laws as significant and dignified as those of any science. When the boy-who-wants-to-know is told that the crystal he is holding in his hand is quartz, he is actually told that any substance of that crystal form, luster, and fracture, always, by the inevitableness of experience which we call natural law, possesses a certain hardness, melting point, behavior towards acids, etc.[5]

If the shell he brought is *Polygyra*, he might be told, "Go back to the woods and collect a few shells just like this—they are common—but with the living animal still in it. You will find that animal possessing two pairs of tenacles, the larger ones each with an eye at the tip. You will find the mantle cavity lined with blood vessels, functioning as a lung. Dissolving the animal's head in potassium hydroxide, you will find a narrow ribbon beset with delicate teeth, many in a row, with specific shapes that can better be drawn than described, and so forth."

To the boy such predictions would seem like magic had he not been told early to accept the dry fact that all things have certain properties. The "properties" of objects are the "laws" of the descriptive sciences.

Conversely, it might be said that the "laws" of the so-called exact sciences are but expressions of "properties." When, over three hundred years ago, Kepler recognized, as a result of observations that extended over more than a decade, that the orbit of Mars is elliptical, he merely discovered a "property" of the planet's orbit. This is true even through his discovery required rare insight, being the result of keen abstractions from a very large number of observations concerning the position of the planet, and involving, furthermore, the assumption that the limited number of determinations was representative of an invariable form of the path.

In the same work (1609) in which he "described" the orbit of Mars, he published two of his bolder generalizations, the first of which stated that the orbits of all planets are ellipses. This, the first of the famous three laws of Kepler, has come down to us as a prototype of "laws." Yet it is purely descriptive.

It is true, it can be expressed in mathematical form. In that case we say, for instance, the paths of all planets are of the form $r = \frac{p}{1-\epsilon \cos \theta}$[6]

[5]H. Poincaré. "The Value of Science," in "The Foundations of Science," the Science Press, 1929, p. 333.

[6]Where r and θ are the variables in polar co-ordinates, p is the "parameter"—the length of the normal erected in the focus measured to its intersection with the curve, and ϵ the "eccentricity" ($\epsilon = \frac{r,}{d}$ where d is the distance from a given line, normal to the major axis). This is the general equation for all conic sections.

But that is no reason for calling it a "law" instead of a "property." Many of the "properties" found in the descriptive sciences can be expressed no less successfully in mathematical form. The shells of nautiloid cephalopods, for instance, grow in the form of a logarithmic spiral, in other words, assume an outline such that the advancing edge follows a path of the form $r = a^{\theta}$[7].

There is a better reason for calling some "properties" laws. It grows out of another aspect of scientific endeavor. The eager youngster in the musuem asks not only, "What?" but also, "Why?" We are ready to tell him the properties of quartz and Polygyra. But then he asks, "Why is quartz so hard?" and "Why does a radula with numerous, closely set, small teeth go with a shell such as Polygyra?" This is a more serious matter. He asked for "knowledge" before, now he calls for "understanding."

What, precisely, do we mean when we say we "understand," in matters of science? In place of giving an abstract answer, let us picture to ourselves what happened when men learned to understand a simple fact of nature, for example, the rainbow.

First of all, this common meteorological phenomenon had to be observed carefully so that it meant more than a curved streak of colors in the sky. Its properties had to be observed and defined carefully, each of which has truly the dignity of a law, such as, "rainbows are segments of circles; the center of the rainbow lies on a straight line drawn through the sun and the observor's eye; a single rainbow is always violet on the inside and red on the outside;" and so forth. But even had he had all this knowledge, Aristotle would have been unable to understand even the simplest elements of the geometry of the rainbow. He ascribed it to the reflection of the sun's rays by the rain. He must have felt as unconvinced as we do about many so-called "explanations" of present day geology. Two hundred years later Ptolemy made a good start toward a study of refraction in what has been described as "the most remarkable experimental research of antiquity."[8]

But no one seems to have noted a possible connection with the rainbow. When the scientific spirit awoke again near the end of the Middle Ages, it was recognized that rainbows owed their origin in some way to refraction, perhaps combined with reflection. Real understanding had to await knowledge of the basic law. When W. Snell discovered (in 1621) the quantitative law of refraction, Descartes was quick to apply it to the problem of the rainbow. His calculated angle agreed with that observed. Men now "understood" the geometric laws concerning the rainbow as special cases of the broader law of refraction. The colors, however, remained a mystery. There were futile attempts at explanations, of course. We would call them working hypotheses today.

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[7]Where, again, r and θ are the variables in polar co-ordinates and a is a constant.

See the chapter on logarithmic spirals (Ch. XI) in D'Arcy W. Thompson's fascinating book "On Growth and Form." Cambridge, 1917, pp. 493–586.

[8]G. Sarton. History of Science, Vol. 1, 1927, p. 274. Quoted from W. C. D. Dampier-Whetham, "A History of Science," 1931, p. 54.

Men might even have entertained "multiple hypotheses" in their search for a solution. The fact remains that no matter how large a number of multiple hypotheses was made, no solution could be found until the basic law was discovered, and cast into suitable form, upon which the solution depended. When Newton found the laws of dispersion, understanding came in a flash. "Understanding," then, as we use the word in science, consists in recognizing a specific law as the special case of a more general law.

Newton's demonstration that all three of Kepler's laws, apparently so different in content, are merely the geometrical implications of an abstraction of by far more general character, is perhaps the most illustrious example of an intrinsically great feat of understanding.[9]

Quite instinctively, certainly without any particular method, we speak of "laws" when we recognize generalizations that are fraught with possibilities of understanding—in contrast to those generalizations which establish relationships to be understood—the properties. Thus we speak of Osborn's law of adaptive radiation in biology, of Ferrel's law in meteorology, of Rosenbusch's law in petrography. The more general a law, the greater its resolving power. In order to be general, it must be abstract. The more abstract it is, the more amenable it is to mathematical treatment—the more exact is the form in which it can be stated.

The sciences that face the objects of experience in their full complexity—such as the plants, animals, rocks, topography, weather—find the mathematical language inadequate to their task. The curves defining the shape of a trilobite or of granite intrusive, like the flow lines of a weir in a river or of the air on a weather map, defy mathematical analysis. Accurate description of reality seen in nature and in experiment form the accumulated store of scientific knowledge in these sciences. From it there arise, through judicious generalizations, "specific laws" that give us the first sense of order in the concrete aspect of complex reality. Back of them, revealed by greater and greater abstraction from reality, we distinguish the more and more general laws of chemistry, physics, mechanics, electrodynamics, mathematics. This is the familiar picture of the hierarchy of the sciences. It is repeated in the structure of every branch of science.

In geology we see geophysicists, students of geotectonics, regional geologists, stratigraphers, petrographers, mineralogists gather observations that are to lead ultimately to an understanding of the complicated spectacle of the earth. Like horizontal strata of decreasing complexity, lie the levels at which these men are working, each forming at least part of the foundation for the work of those above it.

At each level laws must be formulated without which understanding is impossible at the higher levels of complexity. This is the picture the geologist must keep before him if he is to do his best work and derive the deepest satisfaction from it.

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[9]The proof with the mathematical tools that Newton had at his disposal was a very great achievement indeed. In modern vector notation the proof is quite simple and occupies not more than two pages for all three laws.

See Louis Brand, "Vectorial Mechanics." New York, 1930, pp. 401–403.

Let us now see how this works out in practice. Take the case of the igneous rocks. Observations led early to the definition of numerous types and to attempts at classification. Mineral composition and texture were studied comparatively. Here, as always, comparative studies led to generalizations which were more than mere properties of types, generalizations that had the character of the empirical laws. "Nephelite-bearing rocks are free from quartz" is one. Rosenbusch's law concerning the typical sequence of (final) crystallization, from basic to acid minerals, is another.

Not until such laws were formulated could any serious desire for explanations, for "understanding," arise. Before, it would probably have seemed rather silly to ask, "Why is a basalt constituted the way it is?" One might as well ask, "Why do radulas of the *Polygyra* type go with the shells that characterize that genus?" That is the way it is—that is all.

It would certainly have been futile to go to the classical chemistry of the last century for an answer. No number of multiple hypotheses could have led to the trail of understanding; because understanding could not even be conceived until physical chemistry had reached the state of the phase rule.

But even after the basic concepts had been created, much work had to be done before an understanding of the characteristics of mineral associations in igneous rocks became possible. The level between the abstract theory and the complex reality of the rocks had to be filled by experiment on the properties of silicate melts. Investigations in that field are expensive. Industry was slow in entering that no-man's land. When the geophysical laboratory of the Carnegie Institute of Washington was established, it undertook to fill the gap.[10] The Kaiser Wilhelm Institut für Silicatforschung in Berlin-Dahlem was modeled after it. For over three decades the work has gone on. One by one the empirical laws of petrography are becoming intelligible, if not fully understood, in the light of the properties of silicate melts. Thus formulation of empirical laws. systematic exploration of artificially simplified systems: those are the steps from which springs the understanding of reality which is the ultimate aim of science.

Let us turn to another illustration. In a sense, mineralogic-petrographic studies on igneous rocks are not typical of geologic work. The units with which they deal can be taken into the laboratory, weighed, studied under the microscope, analyzed chemically.

Geologic investigations in the strict sense of the term, on the other hand, deal with sizable parts of the earth's crust. While these are, of course, small compared with the objects studied by the astronomer, they have the disadvantage of being right up against us. They are vast compared to man's size. The amount of physical labor and time consumed in merely traversing the objects of study looms large. The methods of the surveyor and cartographer and graphic representations

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[10]It is instructive to read the diverse suggestions which were received by the advisory committee on geophysics from outstanding geologists and geophysicists, at the founding of the Carnegie Institution (Year Book No. 1, 1902, pp. 44–70) and contrast with them the purposeful limitation of the work which was ultimately adopted and which has led to such uniquely valuable results.

of diverse kinds must be used to record the knowledge gained. In typical cases the work of several men and of several field seasons is required to furnish a reasonably accurate description of one object of study, one individual, if you please.

Take the case of the oil-bearing strata of the Green River shale—sediments of a long extinct lake in western Colorado, Wyoming, and Utah. In order merely to describe this stratigraphic individual adequately, it is necessary to traverse along as many lines as possible the 25,000 square miles covered by these sediments; to study the variations in the sediments, especially the near-shore phases; to measure the rhythmic lamination of the sediments, which is such a conspicuous feature of the formation, throughout the 2,000 feet of thickness and to compare the results for as many sections as possible; to look for and study carefully zones with significant minerals, such as a rather unique analcite bed and more numerous layers of other peculiar minerals; to study the nature of the organic material, chemically and above all with the microscope and microtome; to make collections, as exhaustive as possible, of the fossil leaves, insects, fishes, for which the beds are famous and to establish the taxonomic identity of the microscopic and megascopic forms found. Vast labors in the field, in the laboratory, the herbarium, and museum by a score or more of men were needed to complete, in the course of years, a reasonably accurate description of this formation.

The result of all this labor is the description of a *single individual*, one body of deposits. No laws can be derived from this individual. But laws are needed to understand its properties.

Take the most conspicuous property of these beds, the fine lamination that runs with mathematical accuracy through every microscopic section, in endless alternations of pairs of layers, measured in tenths of millimeters, one chiefly organic matter, the other largely inorganic. What does it mean?

Many possible explanations come to mind. The geologist, more than other men of science, must work with multiple hypotheses. For understanding, the geologist turns to limnology. One "law" of limnology suggests an explanation: the plancton of lakes reaches annually a relatively short peak dropping to a minimum for the rest of the year. The microscope shows that the organic matter of the laminae consists of plancton. Here is a possible answer. Another "law" of limnology[11] points to the same answer: the deposits at the bottoms of modern lakes in moist climates show similar alternations of organic (planctonic) and inorganic laminae.

The Green River beds represent part of the Eocene period. Radioactive minerals have furnished data which give a rough estimate of the length of the Eocene period. This can be compared with the length of time represented by the fraction of it comprised in the Green River shales, computed on the assumption that each pair of laminae records

[11] B. W. Perfiliew. "Das Gesetz der Periodizitat der Schlammbildung und die Tiefgewässer-Bohrung." Verh. Intern Verein. f. Limnologie, 1931, Vol. 5, pp. 298–306. (Known to the writer at present only through a review in Bot. Zentralbl., Vol. 164, p. 98, 1931, to which Dr. Th. Just called the writer's attention.)

one year. The figure found, 6,000,000 years, compares favorably. One more test suggests itself. The thickness of the pairs of laminae is variable. If they represent deposits of one year each, their varying thickness must somehow be connected with fluctuations of climate. A "law" of climatology proves useful: climatic variations proceed in complex curves in which definite cycles are recognizable. When plotted, the laminae of the Green River shale reveal the same cycles.

Thus each new investigation points in the same direction: we are getting nearer and nearer to a satisfactory understanding.[12]

This case is typical of geological work. The empirical laws formulated in the course of studies on living environments and processes—although not labeled as such—form the means of understanding the properties of an individual of stratigraphy—the Green River lake beds.

But there are other famous fossil lake beds—like those of Florissant in Colorado or of Oeningen in Switzerland and many others, little studied. As one by one they are described and analyzed, common properties will be recognized and formulated. There are already in existence interesting discussions of the "Criteria" for lacustrine sediments.

The field of structural geology represents a higher level of complexity in geologic studies. In certain belts the strata of the earth's crust lie deformed: broken by fractures, or crushed along shear zones, bent into folds and thrust one on top of the other along thrust planes. Here the difficulties in the way of study are multiplied. Even if the earth's crust were transparent and the actual features of the deformation could actually be seen to the depth of a mile or two, the mere task of recording, in intelligible manner, the three-dimensional pattern of a folded mountain chain would present great difficulties. With only the surface accessible to the eye and most of it concealed by vegetation and mantle rock, the unraveling of the structure of such regions as the Alps or the Scottish Highlands represents a herculean task, for the body as well as the mind.

While the anatomist can produce hundreds of sections with his microtome in a fraction of an afternoon, it takes years of topographic surveying and decades of geologic mapping, each man refining and correcting the observations of his predecessors, before a series of reasonably accurate cross-sections can be produced through such a region as the Swiss Alps or the folded Appalachians. Here again, then, the descriptions of individuals is still, by force of circumstances, the dominant occupation of the geologist.

Nevertheless, it is just in this field, that the search for typical patterns, for laws of deformations began early. Types of folds and patterns of fractures were early recognized and given names. The practical importance of many structural features in mining and prospecting led to a high development of the formal aspects of rock deformation. As early as 1878 Albert Heim's "Untersuchungen uber den Mechanismus

[12]I have quoted from a series of classical investigations by W. H. Bradley, of the U. S. Geological Survey. See especially, "The Varves and Climate of the Green River Epoch," U. S. G. S., Prof. Paper 158, 1929, pp. 87–110; "Origin and microfossils of the oil shale of the Green River Formation of Colorado and Utah," ibid., Prof. Paper 168, 1931, 58 pp. and 28 plates.

der Gebirgs Bildung" brought exemplary precise formulations of valid generalizations.

But understanding of the structural facts in terms of more basic laws has barely begun. For classical physics, proceeding along strictly inductive lines, had limited itself at first almost entirely to the simplest aspects of the deformation of bodies, which are below the elastic limit, where relatively simple equations can be tested by crucial experiment. Valiant attempts were made by geophysicists to attack the problems of rock deformation with the inadequate tools of the classical theory of elasticity. Papers were written that were learned but not convincing. Understanding could not be expected until physicists ventured forth from the abstract field of simplest cases into the realities of the world of bodies at large. This time industry has filled the gap with its practical demands, and a new empirical science, the physics of materials, has come into existence. Such basic properties as plasticity, strength, rigidity, brittleness are being studied exhaustively. Empirical laws are being cast into mathematical form. Fracture patterns and other forms of deformation are being studied and analyzed. In that way laws of behavior of materials are being formulated out of which ultimately will come a true insight into the nature of geological structures.

One phase of modern studies of granite massifs may serve as a concrete illustration. At the time when the merciless inflation of the after-war period crippled the activities of many German geologists by making distant traveling impossible, Dr. Hans Cloos at Breslau took a devoted body of students into the numerous granite quarries of the nearby mountains of Silesia and carried on systematic studies of the innumerable fractures that cut every granite body in nature.[13] Tens of thousands of readings giving the attitude in space of all important fracture surfaces observed were plotted graphically. Soon definite systems of fractures were recognized that run uniformly through a granite mass: fracture aligned at right angles to the strike; longitudinal fractures; conjugate shearing planes; and pinnate fractures along the contacts. This assemblage of fractures has since been found to be practically universally present in intrusive bodies of granite.[14] Their presence constitutes empirical laws of great value.

When these empirical laws had been established, Dr. Cloos undertook to supply the knowledge that was needed for understanding. In a series of ingenious laboratory experiments, he has attempted to reproduce the essential aspects of orogenic deformation. Reasoning in terms of factors of similitude, he used a mixture of water and clay for his experiments, a substance yielding to gravity and yet of such coherence as to fracture after the fashion of such solids as granite. When he showed his extraordinary results at the next International Congress,

[13]He carried out near his home investigations inspired in pre-war days, by his careful studies of beautifully exposed granite regions in the deserts of Southwest Africa.

[14]For a bibliography of papers by Cloos and his collaborators, see Robert Balk, "Primary Structure of Granite Massives," Bull. Geol. Soc. America, Vol. 36, 1925, pp. 695–696. (A larger paper by the same author, entitled "Structural Behavior of Igneous Rocks," will soon appear as one of the Memoirs of the Geological Societyof America.)

more than one geologist shrugged his shoulders: "What can one learn from wet mud about granite?"[15]

The highest degree of complexity is reached when the earth as a whole becomes the object of study—in what is now widely called geotectonics. Here it is not the details of structure of individual mountain ranges, but the pattern of folded mountains on the face of the earth as a whole that demands attention; not the relations of one plateau to another, but that of the continental platforms to each other and to the oceanic floors; not the events of volcanic outbursts in one region, but the connection that exists between belts of volcanism and belts of deformation; and so forth.

To the complexities of three-dimensional structure, the time element is added as the fourth dimension. The geologist's intricate and still very crude methods of relative timing must be used to determine whether epochs of folding are short, spasmodic events, or long drawn out processes; whether mountain folding takes place simultaneously in many parts of the earth followed by periods of quiet, or whether some folding has been going on somewhere on earth throughout geologic time; whether epochs of mountain folding coincide with times when continents became submerged by a rising sea level, or with times of emergence—and so forth.

In the four volumes of "The Face of the Earth," a work of rare compass, depth and beauty,[16] the product of thirty years,[17] Eduard Suess has laid the foundation for all such inductive studies concerning the deformation of the earth's crust. In this work the masterful picture of the then available knowledge of the structure of the whole face of the earth, covering over 2,700 pages, culminates in a few chapters of "Analyses" and Hypotheses" of only 138 pages[18] which grip by their moderation, the tentative and cautious tone of their interpretations. Fertilized by the fervent enthusiasm and the almost inexhaustible riches of this work, structural analysis has since been carried systematically into most parts of the world. The detailed literature on regional tectonics has grown beyond the grasp even of a genius. But the growing number of authentic summary accounts and of tectonic analyses of limited areas, on the other hand, are making accessible more and more the generalized results from many parts of the earth. From them gradually broader generalizations are being derived that hold good everywhere today and will stand the test of future observations, generalizations that are true "laws." A few such laws were established long ago, as, for

[15]The following papers deal with tektonic experiments of this type in general: H. Cloos. "Experimente zur inneren Tektonik." Centralbl. f. Min. Abt. B, 1928, pp. 609–621; "Künstliche Gebirge." I, Natur und Museum, 1929, pp. 225–243; II, ibid, 1930, pp. 258–269; "Zur experimentellen Tektonik," Naturwissenschaften, vol. 18, 1930, pp. 741–747; "Zur experimentellen Tektonik," Geol. Rundschau, 1930, pp. 353–367; "Zur experimentellen Tektonik," Naturwissenschaften, vol. 19, 1931, pp. 242.

[16]In his epilogue to the French Edition, Termier has called this work "bien un poême, dans le sens complet de ce mot splendid qui veut dire création." "La Face de la Terre," vol. 3, pt. 4, 1918, p. 1713.

[17]Edward Suess. "Das Antlitz der Erde," Vol. I, 1883; Vol. II, 1888; Vol. III, pt. 1, 1901; Vol. III, pt. 2, 1909.

[18]In the English Edition of Sollas and Sollas.

instance, Elie de Beaumont's law of the episodic character of orogeneses (1829); Godwin-Austen's law of the tendency of posthumous folds to trend parallel with the lines of earlier folding (1856); Hall's law of the coincidence of belts of folding with belts of abnormally thick sediments (1859).

Ten years after Suess' death, Stille published his "Grundfragen der vergleichenden Tektonik."[19] The title of this remarkable work makes effective use of the expression "Comparative tectonics" and the text culminates in the formulation of a "law," Stille's "orogenes Zeitgesetz."[20] It is a broad generalization based on two properties of orogenic movements concerning their incidence in time. It is a general law of broad resolving power. The writer believes it to be valid. But geologists are by no means agreed that the two properties on which the law is based are really general and essential. Such a generalization can hardly be called more than an "opinion," until it can be shown to rest on a valid basis. On the whole we are not ready to formulate such broad laws. The first task is to crystallize knowledge concerning the observable properties of the structure of the earth's crust. Stille's book is primarily devoted to this task as far as the time element in orogenesis (and epeirogenesis) is concerned. The speaker has attempted to extend this work to other properties. On the strength of the convictions set forth in this address he spoke of them as "laws," *i. e.*, "specific laws" of crustal deformation, from which ultimately such "general laws" as Stille's will be derived. He might have listed his "specific laws" as "properties." He preferred the more challenging "law." The word he could not use, suggested to him more than once, was "theses." "Too much of the geotectonic literature of the past was concerned with the theses of men rather than with laws of nature."[21]

This, then, is the essence of all geologic work:

1. Not to be satisfied with the accumulation of facts alone, but to draw from them, at every opportunity, all possible generalizations. In other words, to search for the general properties, the "specific laws" in the reality with which we deal, and ultimately for such "general laws" as can be safely formulated.

2. To seek understanding of the empirical laws thus found by studying the findings of workers in the nearest level of complexity. For the geologist, that means stepping from the records of the past to the experiences of the present; from the properties of vast bodies to those of small units of the laboratory; from the complex systems of nature, to simpler systems capable of analysis. It means oceanography, limnology, hydrology, the physics of materials, the physical chemistry of silicate melts, and so forth, not simply elementary textbooks of chemistry or physics.

Neither of these two points is followed as widely as one should expect. As to the first, a multitude of facts is still published with little or no evidence of thought concerning their broader bearings. As to the second, uncontrolled speculation still too often takes the place of that

[19]Berlin, 1924 (Gebr. Borntraeger).

[20]Loc. cit., pp. 44–45.

[21]Walter H. Bucher, "The deformation of the earth's crust." Princeton, 1933, p. VII (Preface).

systematic searching for an adequate foundation for understanding which is needed. When we try to understand the Permian glaciation, we still invoke movements of the continents or of the poles (or both), instead of instigating that prolonged systematic research by competent meteorologists which alone can make sure that wide areal glaciation down to sea-level is impossible in equatorial latitudes; we use similar speculations when we speak of the existence during the geologic past of higher vegetation near the poles,[22] without having brought about investigations needed to decide if trees can grow where the night and day last half a year each; we demand vertical uplift of the continental shelves of nearly two miles to "explain" the submarine valleys before having placed the problem into the hands of experienced hydrologists familiar with the complex currents set up by the tides, and so forth.

Speculation that does not lead directly to further search for facts and laws is idle. The joy of understanding arises from reasoning, not from guessing; from the purposeful grouping of general facts, not from the mere play of the imagination.

Two things remain to be said. One refers to the human side of this task. The other points to the future outlook.

For the human side let us turn back once more to the boy-who-wanted-to-know in the museum. Let us assume that his enthusiasm held out through his high school years—we are optimists, you see. He has pushed through as fast as possible, impatient of any delay, to that field of science which at the time satisfied his fancy. He has become a geologist. The more he learns about the strata and structures, the less he is satisfied with the mere description of "facts." He turns to basic works on limnology, hydrology, physics of materials. And now he finds much that he cannot read. Not only a strange terminology, but the unfamiliar concepts and lines of reasoning of the basic sciences: physical chemistry, vector mathematics, statistics, etc. He wishes he had become a mathematician first, then a physicist, and then a chemist. He looks with envy upon those who work in the abstract fields of artificial simplicity, where knowledge is exact and reasoning rigorous. His own problems seem muddled, his own mind inadequate.

But when he seeks co-operation from the fortunate ones who are mathematicians and physicists, he makes a discovery. Just as he, in the typical case, at his stage of life cannot spend the energy and time necessary to acquire a working knowledge of the mental tools of the basic sciences, so the workers in the abstract sciences find the task too great to acquire the perspective over the intricacies of unabstracted reality without which creative work is impossible. Moreover, he who is accustomed to the "linear order of thought which is necessarily cultivated in . . . mathematics" finds it distasteful, if not difficult, to acquire "the habit of parallel . . " or "complex thought," as T. C. Chamberlin[23]

[22]Since this was written, coniferous wood of araucarian type has been reported, found together with leaf impressions of cycadophytes in the Upper Triassic or Jurassic florule associated with coal, which was collected in south latitude 86-58[1], i. e., within 3 degrees of the South Pole. Wm. C. Darrah, "Antarctic fossil plants," Science, Vol. 83, 1936, pp. 390-391.

[23]T. C. Chamberlin, "The Method of Multiple Working Hypotheses," Jour. Geol., Vol. 39, 1931, p. 164. (Reprinted from the original in Jour. Geol., Vol. 5, 1897, pp. 837-848.)

once called it, in which a multitude of interrelated properties must be visualized and weighed as parts of an integral whole.

The recognition of this difference is wholesome. Every geologist needs such an experience to find the right pride in his work. The worker in the complex levels of science is the explorer, the man from the basic sciences the guide. One derives his significance from the other, and both derive the sense of dignity in their calling from the joint goal which is an ordered insight into complex reality.

As to the outlook for the future: I have spoken so far of two steps that enter into the mental process of the geologist. But there are really three:

First comes: *Analysis*, *"re-solving"* the complexity of geological reality into its constituent, essential elements of orderly recurrence, formulated as generalizations which we call "properties" or "specific laws."

Second: *Interpretation*, *"translating"* these "properties" or "specific laws" into the terms of the more "general laws" of the basic sciences. This constitutes "understanding."

The third is: *Synthesis*, *"putting together"* again, collecting in our consciousness the numerous threads of understanding into one adequate perspective of nature as we see it in its entirety.

"Analysis" is in full swing. "Interpretation, and with it "understanding," is growing, as laws are being formulated in the fields of investigation that lie between geology and the basic sciences.

But in the larger aspects of geology the final synthesis which is to give us a satisfying, logically consistent and coherent picture of the earth and the forces that have formed and are forming it, is a hope for the future. It will be brought about by the growth of a tendency which is taking form now. Analysis produces specialists; the growing need for synthesis will produce encylopedists. H. G. Wells put it this way: "The world, if all goes well with it, will consist very largely of specialists, who know every detail about and every relationship of something, and of people . . who will know everything in outline and in correlation. Specialism and encyclopedism are necessary correlatives."

Analysis and interpretation require the field and the laboratory. Synthesis is done in the philosopher's study. Most geologists, and for that matter most scientists at large, mistrust the man who studies not nature, but natural laws. His work looks like the boring and hoarding of the bookworm. Most scientists are still unaware of the difference between unimaginative compiling, the cataloguing of facts, and the creative power that is required for all true synthesis. Yet it is such synthesis alone which can make us fully aware of nature. For, to see the work of many in one perspective, to realize the common bond of natural law that permeates all our experiences of nature, means to realize the "internal harmony of the world" which, as Poincaré pointed out repeatedly,[24] is "The only true objective reality," the ultimate goal of all science.

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[24]H. Poincaré in "The Foundation of Science," The Science Press, 1929, e. g., pp. 207, 209.

ADDITIONS TO THE REVISED CATALOG OF OHIO VASCULAR PLANTS. IV[1]

JOHN H. SCHAFFNER

The past year has been one of great activity in the development of the Ohio State Herbarium. A number of very large collections have been received from various botanists and these have mostly been named and mounted. About 5,000 specimens have been mounted and added to the herbarium. This substantial growth of the collection was made possible through the assistance of six students working under N. Y. A.

Mr. Wm. C. Werner, of Painesville, who died in 1935, had expressed the desire that his private collection of plants should be presented to the State Herbarium. Accordingly, through the kindness of Mr. C. J. Werner, of Painesville, the entire Werner herbarium was sent to the Department of Botany and is being added to the State Herbarium. Wm. C. Werner was one of the early instructors in the Department of Botany of the Ohio State University and a co-author with Wm. A. Kellerman of the "Catalogue of Ohio Plants," published by the Ohio Geological Survey in 1893.

Dr. W. H. Camp has furnished a number of rare records obtained from specimens in the herbarium of the New York Botanical Garden. These are so designated unless there are also duplicates in the Ohio State Herbarium. Among the records given below are 37 species new to the Ohio list. One of these is a species new to science and three are records from other herbaria. Of the 35 newly listed species, 26 are apparently native and 11 are plants escaped from cultivation or accidental. The new species is represented by specimens collected in Jackson County by Pontius and Bartley. A slight beginning has been made in a revision of the nomenclature to bring it into agreement with the newly established International Rules. This revision will require a large amount of work and a considerable period of time for its accomplishments. In the meantime the American Code names will mostly be used until a complete change can be made to the new standard. This will be the most convenient procedure, especially since there is still no manual of the plants of the eastern United States available with the new nomenclature.

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[1]Papers from the Department of Botany, The Ohio State University, No. 369.

3. *Botrychium neglectum* Wood. Wood's Grape-fern. Sugar Grove, Fairfield County. Glenn W. Blaydes and R. E. Shanks.

10.2. *Trichomanes boschianum* Sturm. Filmy-fern. Section 25, Laurel Twp., Hocking Co. Chas. R. Goslin.

12. *Polypodium polypodioides* (L.) Hitch. Gray Polypody. Columbia Twp., Meigs Co. Clyde H. Jones.

42a. *Polystichum acrostichoides schweinitzii* (Beck.) Small. Ten Mill Creek, near Sylvania Ave., 7 miles from city limits, Toledo. Lucas Co. Richard Wood.

47. *Pteretis nodulosa* (Mx.) Nieuwl. American Ostrich-fern. In moist low woods. West of Toledo along Ten Mile Creek, Lucas Co. Richard Wood.

60. *Equisetum silvaticum* L. Wood Horsetail. Edge of Clover Hill Bog. N. Bloomfield Twp., Trumbull Co. R. E. Shanks.

66.1. *Lycopodium tristachym* Pursh. Slender Trailing Clubmoss. Laurel Twp., Hocking Co. Gordon Van Buskirk.

68. *Selaginella rupestris* (L.) Spring. Rock Selaginella. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

75.1. *Pinus nigra* Arn. Austrian Pine. Escaped from Cultivation at Geneva-on-the-Lake, Ashtabula Co. L. E. Hicks.

75.2. *Pinus silvestris* L. Scotch Pine. Escaped from cultivation. Geneva-on-the-Lake. Ashtabula Co. L. E. Hicks.

93. *Potamogeton pulcher* Tuck. Spotted Pondweed. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

96. *Potamogeton heterophyllus* Schreb. Variant-leaf Pondweed. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley. (N. Y. Bot. Garden).

98. *Potamogeton epihydrus* Raf. Nuttall's Pondweed. Salt Creek, Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

106. *Potamogeton vaseyi* Robb. Vasey's Pondweed. Mosquito Creek, Howland Twp., Trumbull Co. Almon N. Rood and R. E. Shanks.

112.1. *Naias guadalupensis* (Spring.) Morong. Guadaloupe Naias. Washington Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.

123. *Sparganium lucidum* Fern. & Eam. Shining-fruited Bur-reed. In alder swamp, Killbuck, Holmes Co., and Beach City, Stark Co. W. H. Camp and P. Zimpfer. Also swamp south of Delaware, Delaware Co. W. H. Camp.

135.1. *Lemna minima* Philippi. Least Duckweed. Benton Twp., Paulding Co. L. E. Hicks.

135.2. *Lemna perpusilla* Torr. Minute Duckweed. Washington Twp., Mercer Co. L. E. Hicks.

144.1. *Scirpus georgianus* Harper. Georgia Bulrush. Salem Twp., Meigs Co. Clyde H. Jones.

150. *Scirpus planifolius* Muhl. Flat-leaf Clubrush. Salt Creek Twp., Hocking Co. Mary Anna Drake.

159. *Eleocharis tenuis* (Willd.) Schultes. Slender Spike-rush. "Neotoma," Hocking Co. E. S. Thomas and R. B. Gordon.

163. *Eleocharis engelmanni* Steud. Engelmann's Spike-rush. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

166. *Stenophyllus capillaris* (L.) Britt. Hair-like Stenophyllus. Duncan Falls, Muskingum Co. L. E. Hicks and C. A. Dambach.

168.1. *Cyperus refractus* Engelm. Reflexed Cyperus, Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

169.1. *Cyperus lancastriensis* Port. Lancaster Cyperus. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley. Salisbury, Meigs Co. Clyde H. Jones.

169.2. *Cyperus torreyi* Britt. Torrey's Cyperus. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

172. *Cyperus speciosus* Vahl. Michaux's Cyperus. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

190. *Scleria pauciflora* Muhl. Papillose Nut-rush. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

205. *Carex aggregata* Mack. Glomerate Sedge. Pickaway Twp., Pickaway Co. Mary Anna Drake. Salem, Meigs Co. Clyde H. Jones.

210. *Carex brachyglossa* Mack. Yellow-fruited Sedge. Pickaway Twp., Pickaway Co. Mary Anna Drake.

230.1. *Carex projecta* Mack. Necklace Sedge. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

292. *Carex caroliniana* Schw. Carolina Sedge. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

330. *Bromus japonicus* Thunb. Japanese Field Chess. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius. (New York Bot. Garden).

360.1. *Poa palustris* L. Fowl Blue-grass. In fields. Oberlin, Lorain Co. Coll. W. M. Dick. From F. O. Grover.

362.1. *Poa wolfii* Scribn. Wolf's Spear-grass. Adams Co. E. Lucy Braun. (In Braun Herb.)

369. *Eragrostis poaeoides* (L.) Beauv. Low Love-grass. (*Eragrostis eragrostis* (L.) Karst.). Lancaster, Fairfield Co. Robert and William Goslin.

375. *Sphenopholis pallens* (Spreng.) Scribn. Change name to Spenopholis intermedia (Rydb.) Rydb. Tall Wedge-grass.

384. *Danthonia compressa* Aust. Flattened Wilt-oat-grass. Salem, Meigs Co. Clyde H. Jones.

391. *Deschampsia flexuosa* (L.) Trin. Wavy Hair-grass. Berne Twp., Fairfield Co. Robert Goslin.

397. *Sporobolus asper* (Mx.) Kunth. Longleaf Rush-grass. Perry, Lake Co. F. J. Tyler.

400.1. *Calamagrostis insperata* Swallen. From the collection from which the type specimen was obtained. Ofer Hollow, Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

416. *Muhlenbergia sobolifera* (Muhl.) Trin. Rock Muhlenbergia. Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

430. *Aristida purpurascens* Poir. Purplish Triple-awn-grass. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

438. *Lolium multiforum* Lam. Awned Darnel. Liberty Twp., Highland Co. Katie M. Roads.

447. *Elymus striatus* Willd. Slender Wild-rye. Yellow Springs, Greene Co. Delzie Demaree.

456.2. *Gymnopogon ambiguus* (Mx.) B. S. P. Broad-leaf Naked Beard-grass. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

475. *Panicum perlongum* Nash. Long-stalked Panic-grass. Lynx, Adams Co. R. B. Gordon and A. R. Harper.

483.1. *Panicum yadkinense* Ashe. Spotted-sheath Panic-grass. In bottoms, Shawnee State Forest, Scioto Co. Delzie Demaree.

484. *Panicum boreale* Nash. Northern Panic-grass. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley. (N. Y. Bot. Garden.)

486.1. *Panicum barbulatum* Mx. Barbed Panic-grass. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

490. *Panicum tsugetorum* Nash. Hemlock Panic-grass. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius. (N. Y. Bot. Garden).

498a. *Panicum boscii molle* (Vasey) Hitchc & Ch. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley. (N. Y. Bot. Garden).

499. *Leptoloma cognatum* (Schultes) Chase. Fall Witch-grass. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

500. *Syntherisma filiforme* (L.) Nash. Slender Crab-grass. Liberty Twp. Jackson Co. Leslie L. Pontius and Floyd Bartley.

504. *Echinochloa frumentacea* (Roxb.) Link. Billion-dollar-grass. Along the road in southwestern Fayette Co. Katie M. Roads.

505.2. *Paspalum pubiflorum glabrum* Vasey. (*P. laeviglume* Scribn.). Smooth-glumed Paspalum. Pickaway Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.

505.3. *Paspalum laeve* Mx. Field Paspalum. Letart Twp., Meigs Co. Clyde H. Jones.

508. *Paspalum setaceum* Mx. Slender Paspalum. Liberty Twp., Highland Co. Katie M. Roads.

508.2. *Paspalum longipedunculatum* LeC. Long-stalked Paspalum. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

514.1. *Holcus sudanensis* Bailey. Sudan-grass. Escaped to low pasture land. Glenford, Perry Co. L. E. Hicks and C. A. Dambach.

517. *Miscanthus sinensis* Anderss. Chinese Plume-grass. Salisbury, Meigs Co. Clyde H. Jones.

520. *Andropogon elliottii* Chapm. Elliott's Beard-grass. Salem, Meigs Co. Clyde H. Jones.

525. *Yucca filamentosa* L. Adam's-needle. Salem, Meigs Co. Clyde H. Jones.

575. *Clintonia umbellulata* (Mx.) Torr. White Clintonia. White's Gulch, Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

579. *Smilax ecirrhata* (Engelm.) Wats. Upright Smilax. Killbuck, Holmes Co. Sugar Creek Twp., Stark Co. W. H. Camp.

597.1. *Juncus interior* Wieg. Inland Rush. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

606. *Juncus brachycarpus* Engelm. Short-fruited Rush. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

611. *Juncoides carolinae* (Wats.) Ktz. Hairy Wood-rush. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

613. *Juncoides bulbosum* (Wood) Small. Bulb-bearing Wood-rush. Black Hand, Licking Co. E. R. Shilling, Jr. "Neotoma," Hocking Co. E. S. Thomas and Robert B. Gordon.

614. *Xyris torta* Smith (= *X. flexuosa* Muhl.) Slender Yellow-eyed-grass. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

615. *Eriocaulon septangulare* With. Seven-angled Pipewort. Lake Brady, Portage Co. E. R. Shilling Jr.

631.1. *Iris chamaeiris* Bertol. Evergreen Dwarf Garden Iris. Escaped from cultivation in Columbus, Franklin Co. Adolph E. Waller and John H. Schaffner.

643. *Gymnadeniopsis clavellata* (Mx.) Rydb. Green Wood-orchis. Nile Twp., Scioto Co. F. B. Chapman.

657. *Ibidium praecox* (Walt.) House. Grass-leaf Lady's-tresses. Nile Twp., Scioto Co. F. B. Chapman. Salem, Meigs Co. Clyde H. Jones.

678. *Magnolia acuminate* L. Cucumber Magnolia. Large tree in forest near Westerville, Franklin Co. W. H. Camp.

682. *Ranunculus micranthus* Nutt. Rock Crowfoot. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

695. *Ranunculus delphinifolius* Torr. Yellow Water Crowfoot. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

787. *Thlaspi perfoliatum* L. Perfoliate Penny-cress. Hillsboro, Highland Co. Katie M. Roads.

794. *Cheirinia repanda* (L.) Link. Repand Cheirinia. Berne Twp., Fairfield Co. Robert Goslin and Wm. Goslin.

822. *Cardamine arenicola* Britt. Sand Bitter-cress. Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

867. *Linum striatum* Walt. Ridged Flax. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius (N. Y. Botanic Garden.)

876. *Zanthoxylum americanum* Mill. Prickly-ash. Bloomfield Twp., Trumbull Co. R. E. Shanks.

882.1. *Polygala curtissii* Gr. Curtiss' Milkwort. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

883. *Polygala incarnata* L. Pink Milkwort. Nile Twp., Scioto Co. F. B. Chapman.

885. *Polygala ambigua* Nutt. Loose-spiked Milkwort. Manchester Twp., Morgan Co. W. Paul Haskins.

943. *Hypericum boreale* (Britt.) Bickn. Northern St. John's-wort. Sugar Grove, Fairfield Co. George A. Heffner and Glenn W. Blaydes.

987. *Viola fimbriatula* Sm. Ovate-leaf Violet. Adams Twp., Lucas Co. Louis W. Campbell. Vincent, Washington Co. C. F. Walker and J. W. Sites.

1035. *Dianthus armeria* L. Deptford Pink. Near Delaware, Delaware Co., and North of Sugar Grove, Fairfield Co. Glenn W. Blaydes.

ELATINACEAE. Water-wort Family

1041.1. *Elatine brachysperma* Gr. Short-seeded Water-wort. Edge of small pond. Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

1050. *Celosia cristata* L. Cock's-comb. long Olentangy R., Columbus, Franklin Co. Nicholas H. Alter.

1089.1. *Centunculus minimus* L. Chaffweed. Liberty Twp., Jackson Co., and Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

1103. *Pleuropterus zuccarinii* Small. Japanese Knotweed. Yellow Springs, Greene Co. Delzie Demaree.

1131. *Geum flavum* (Port.) Bickn. Cream-colored Avens. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1188. *Prunus mahaleb* L. Mahaleb Cherry. Margin of Woods. Rock House State Park. Hocking Co., and John Bryan State Park, Greene Co. Delzie Demaree.

1195. *Prunus nigra* Ait. Canada Plum. Oregon Twp., Lucas Co. Collected by Max Shephurst. Specimens also in the herbarium from Hancock, Shelby, and Clermont Cos. Determined by W. H. Camp from material originally labeled otherwise.

1204. *Aronia atropurpurea* Britt. Purple Chokeberry. Ganges, Richland Co. R. T. Wareham.

1206.2. *Amelanchier spicata* (Lam.) C. Koch. Low June-berry. On rocky bank. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1207. *Amelanchier sanguinea* (Pursh.) DC. Roundleaf Juneberry. Madison Twp., Richland Co. Fred W. Wagner.

1213.1. *Crataegus neofluviatilis* Ashe. New River Hawthorn. Reported from Northwestern Ohio.

1265. *Astragalus carolinianus* L. Carolina Milk-vetch. Union Twp., Scioto Co. Conrad Roth.

1288.1. *Lespedeza formosa* Koehne. (L. sieboldi Miq.) Purple Bush-clover. From Japan. Escaped from cultivation. Zanesville, Muskingum Co. Lawrence E. Hicks.

1293. *Lespedeza stuvei* Nutt. Stuve's Bush-clover. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1314. *Lathyrus latifolius* L. Everlasting Pea. Blanchester, Clinton Co. Katie M. Roads.

1326. *Strophostyles pauciflora* (Benth.) Wats. Small Wild Bean. Along R. R. Conesville, Muskingum Co. L. E. Hicks and C. A. Dambach.

1328.1. *Sedum sarmentosum* Bunge. Creeping Stonecrop. A persistent escape and very prolific. From China. In a vacant lot. Hillsboro, Highland Co. Katie M. Roads.

1345.1. *Lythrum hyssopifolia* L. Hyssop Loose-strife. Washington Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

1349. *Rhexia virginica* L. Virginia Meadow-beauty. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

1361. *Vitis cinerea* Engelm. Ashy Grape. Salem, Meigs Co. Clyde H. Jones.

1427. *Quercus marilandica* Muench. Black-Jack (Oak.) Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

1432.1. *Quercus schneckii* Britt. Schneck's Oak. Originally identified as Q. texana Bulk. Franklin Co., Columbus, W. A. Kellerman, Georgesville, Wm. C. Werner. Valley Twp., Scioto Co. Conrad Roth.

1436.1. *Corylus rostrata* Ait. Beaked Hazelnut. Adams Co. E. Lucy Braun.

1448.1. *Carya ovalis* Sarg. (Hicoria). Oval Pignut (Hickory). Ft. Ancient State Park, Oregonia, Warren Co. Delzie Demaree.

1468. *Salix pentandra* L. Bayleaf Willow. In low ground. John Bryan State Park, Yellow Springs, Greene Co. Delzie Demaree.

1482a. *Salix humilis tristis* (Ait.) Griggs. Upper Rocky Fork, Scioto Co. Delzie Demaree.

1483.1. *Tetragonia expansa* Murr. New-Zealand-spinach. Spontaneous and growing as a weed in flower beds. Liberty Twp., Highland Co. Katie M. Roads.

1497. *Grossularia reclinata* (L.) Mill. Garden Gooseberry. Escaped near Painesville, Lake Co. Wm. C. Werner.

1523. *Myriophyllum heterophyllum* Mx. Variant-leaf Water-milfoil. Mosquito Creek, Howland Twp., Trumbull Co. Almon N. Rood and R. E. Shanks. In a recently-made fish pond. Hillsboro, Highland Co. Katie M. Roads.

1528. *Cucurbita pepo* L. Pumpkin. A numebr of plants growing wild in waste ground. North of Columbus, Franklin Co. John H. Schaffner.

1555. *Hypopitys americana* (DC). Small. Smooth Pinesap. Nile Twp., Scioto Co. F. B. Chapman.

1580. *Phlox stolonifera* Sims. Creeping Phlox. Columbiana Twp., Meigs Co. C. H. Jones.

1595. *Cuscuta epithymum* Murr. Clover Dodder. Salem, Meigs Co. Clyde H. Jones.

1613.1. *Ligustrum obtusifolium* S. & Z. Blunt-leaf Privet. Escaped from cultivation. From Japan. In the edge of a locust thicket, Marshall Twp., Highland Co. Katie M. Roads.

1616.1. *Fraxinus profunda* Bush. Pumpkin Ash. In the Illinoian Till Plain of S. W. Ohio. North of Ft. Ancient, Warren Co. Also in Brown Co. E. Lucy Braun Herbarium.

1641. *Asclepiodora viridis* (Walt.) Gr. Oblong-leaf Green Milkweed. Salem, Meigs Co. Clyde H. Jones.

1650. *Asclepias variegata* L. White Milkweed. Nile Twp., Scioto Co. Conrad Roth.

1657. *Vincetoxicum obliquum* (Jacq.) Britt. Large-flowered Vincetoxicum. Columbia Twp., Meigs Co. C. H. Jones.

1660.1. *Petunia axillaris* (Lam.) B. S. P. White Petunia. Escaped from cultivation. From S. Amer. Along Muskingum R. near Conesville, Coshocton Co. L. E. Hicks and C. A. Dambach.

1666.1. *Physalis subglabrata* Mack. & Bush. Smooth Groundcherry. Mentor, Lake Co. Wm. C. Werner. Specimens also in the herbarium from Lorain, Franklin, Ross, and Clermont Cos.

1673. *Physalis pruinosa* L. Tall Hairy Groundcherry. Buchanan, Pike Co. Katie M. Roads.

1687. *Penstemon pallidus* Small. Downy White Beard-tongue. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

1703. *Ilysanthes inaequalis* (Walt.) Penn. (New Name Lindernia inaequalis (Walt.) Penn.) Long-stalked False Pimpernel. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

1722. *Veronica anagallis-aquatica* L. Water Speedwell. Columbus, Franklin Co. E. T. Wherry and F. W. Pennell.

1737.1. *Linaria dalmatica* (L.) Mill. Dalmatian Toad-flax. In an alfalfa field. North of Worthington, Franklin Co. From Macedonia, Europe. Clyde H. Jones.

1742. *Kickxia elatine* (L.) Dum. Sharp-pointed Cancerwort. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1743. *Cymbalaria cymbalaria* (L.) Wettst. Kenilworth-ivy. Berne Twp., Fairfield Co. Robert Goslin.

1786.1. *Vitex negundo incisa* Clarke. Escaped near W. Alexandria, Preble Co. From Eastern Asia. L. E. Hicks.

1824. *Lycopus uniflorus* Mx. Northern Water-hoarhound. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1844. *Meehania cordata* (Nutt.) Britt. Meehania. Salem, Meigs Co. Clyde H. Jones.

1878. *Plantago arenaria* W. & K. Sand Plantain. Along R. R., Columbus, Franklin Co. Arthur R. Harper.

1923. *Foeniculum foeniculum* (L.) Karst. Fennel. Liberty Twp., Highland Co. Katie M. Roads.

1962. *Galium mollugo* L. White Bedstraw. Blue Creek, Adams Co. R. B. Gordon and A. R. Harper.

1994. *Lonicera sempervirens* L. Trumpet Honeysuckle. Salem, Meigs Co. Clyde H. Jones.

2053. *Helianthus mollis* Lam. Hairy Sunflower. North of Pomeroy, Meigs Co. Conrad Roth, Roosevelt State Park, Nile Twp., Scioto Co. F. B. Chapman.

2070. *Cosmos bipinnatus* Cav. Cosmos. Blanchester, Clinton Co., and Southwestern Fayette Co. Katie M. Roads.

2086. *Coreopsis tinctoria* Nutt. Golden Tickseed, Berne Twp., Fairfield Co. Robert Goslin.

2089. *Chrysogonum vitginianum* L. Chrysogonum. Dunham Twp., Washington Co. C. F. Walker and J. W. Sites.

2094. *Silphium laciniatum* L. Compass-plant (Rosin-weed). Along railway track, North Columbus. Doubtfully native. A. R. Harper. Same place John H. Schaffner.

2110. *Anaphalis margaritacea* (L.) Benth. & Hook Pearly Everlasting. Zanesville, Muskingum Co. C. A. Dambach and L. E. Hicks.

2117. *Chrysopsis graminifolia* (Mx.) Ell. Grass-leaf Golden-aster. Green Twp., Adams Co. Conrad Roth.

2131.1. *Solidago altissima* L. Tall Goldenrod. Perry, Lake Co. F. J. Tyler. Chester, Meigs Co. Clyde H. Jones.

2143. *Bellis perennis* L. European Daisy. On old lawns. Bloomfield Center, Trumbull Co. R. E. Shanks.

2144.1. *Boltonia latisquama* Gr. Broad-sealed Boltonia. Escaped at Perry, Lake Co. Seeds itself in waste ground near nurseries. From the Missouri-Oklahoma region. F. J. Tyler.

2165. *Aster concinnus* Willd. Narrow-leaf Smooth Aster. Olive, Meigs Co. Clyde H. Jones.

2183. *Leptilon divaricatum* (Mx.) Raf. Low Horseweed. Liberty Twp., Wood Co. Helene Miller.

2191.1. *Eupatorium pubescens* Muhl. Hairy Thoroughwort. Kunkle's Hollow, Hocking Co. R. B. Gordon.

2198.1. *Kuhnia glutinosa* Ell. Glutinous False Boneset. Georgesville, Franklin Co. Wm. C. Werner (In N. Y. Bot. Garden). Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

2201.1. *Lacinaria shortii* Alex. Short's Blazing-star. Specimen from "Ohio" in N. Y. Bot. Garden collected in 1842. Probably collected in southern Ohio. Reported by W. H. Camp.

2206. *Vernonia missurica* Raf. Missouri Ironweed. Salem, Meigs Co. Clyde H. Jones.

2223. *Artemisia ludoviciana* Nutt. Western Mugwort. A roadside weed on the Gage farm. Painesville, Lake Co. F. J. Tyler. Zanesville, Muskingum Co. L. E. Hicks and C. A. Dambach.

2233. *Senecio pauperculus* Mx. Balsam Squaw-weed. Columbia, Meigs Co. Clyde H. Jones.

2234. *Senecio plattensis* Nutt. Prairie Squaw-weed. Waterville Twp., Lucas Co. Louis W. Campbell.

2254. *Onopordon acanthium* L. Scotch Thistle. New Paris, Preble Co. Paul J. Hanes.

2255. *Centaurea jacea* L. Brown Star-thistle. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

2259. *Centaurea maculosa* Lam. Spotted Star-thistle. Salem, Meigs Co. Clyde H. Jones.

THE ALIMENTARY TRACT OF THE MARGINED BLISTER BEETLE, EPICAUTA CINEREA MARGINATA FAB. (COLEOPTERA—MELOIDAE)[1]

RAY THOMAS EVERLY
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During the Fall of 1927, while engaged on field work for the United States Department of Agriculture in Meigs and Monroe counties in southeastern Ohio, several heavy infestations of adult blister beetles of the species *Epicauta cinerea* Forst. variety *marginata* Fab., (the margined blister beetle), were observed upon the flowering spikes of ragweed, (*Ambrosia elatior* L.), and several hundred specimens were collected. These were fixed in Kahle's solution and stored in 70% alcohol.

Sections were made of the internal organs and stained with haemalum and fast green. Repeated trials proved that overstaining in haemalum, 2 to 3 hours, and very short staining in the fast green, 8 to 10 seconds, gave the best differentiation of the tissues and cells. All sections were cut 10 microns in thickness.

The investigation was carried on under the direction of Dr. C. H. Kennedy, to whom appreciation is expressed, and to fellow students in the graduate department of Entomology, in particular to Mr. R. H. Davidson, Mr. P. E. Schaefer, and Mr. F. B. Whittington, and to Mrs. Laura Wadsworth Everly for assistance with the manuscript.

THE GROSS ANATOMY OF THE DIGESTIVE TRACT

The alimentary tract in general, is similar to that found in other coleopterous insects. It consists of three main divisions, the fore-intestine, (stomodeum), the mid-intestine, (mesenteron), and the hind-intestine, (proctodeum), and is approximately one and one-third times the body length, (Plate I, Fig. 3). The fore and hind-intestines are ectodermal in origin, whereas the mid-intestine originates from the mesoderm.

THE FORE-INTESTINE

The fore-intestine occupies approximately one-fourth the alimentary tract and consists of the oesophagus, a long narrow tube showing but little variation in diameter until just before reaching the mid-intestine,

[1]Thesis presented as partial fulfillment of the requirements for the degree of Master of Science.

where it abruptly widens into the gizzard. There is no external constriction at the oesophageal valve. Sections of the gizzard show very characteristic foldings of the intima, (INT, Plate I, Fig. 1). The oesophageal valve is definitely a part of the fore-intestine, as a tension placed upon the alimentary tract separates the fore and mid-intestines, the oesophageal valve remaining attached to the former. A gross examination discloses this valve to consist of four finger-like projections, which extend into the mid-intestine about one-fifth its length. These projections are attached at the base and are free the greater portion of their length. They appear to be of similar shape and size, (Plate II, Fig. 4). The outer edges are heavily chitinized on the basal third and gradually less so to the apex. This chitin is pigmented with a yellow color, which is retained in sections and does not stain.

THE MID-INTESTINE

The mid-intestine occupies about one-fourth the entire alimentary tract. It is a large and broad organ, filling the greater portion of the abdomen. Externally it appears folded and covered with minute papillae, the latter being the infolding of the epithelial tissue, which is apparent through the thin translucent connective tissue surrounding the entire mid-intestine.

THE HIND-INTESTINE

The mid-intestine narrows more or less abruptly into the hind-intestine. At this point the six malpighian tubules first enter the tract. Posterior to their point of entrance, the ileum turns abruptly anteriorly. Along this curvature striations or ridges appear externally, which are apparently due to the peculiar arrangement of the circular muscles and the heavier longitudinal muscles at this point, (C M, L M, Plate III, Fig. 8). This part of the intestine appears dark and heavy walled, attributable to the heavy musculature of this part of the hind-intestine. The ileum proceeds anteriorly to about the midpoint of the mid-intestine, at which point the six malpighian tubules enter the tract the second time. At this point of entrance they do not penetrate into the lumen, but remain just beneath the connective tissue. Here the ileum once more turns and then proceeds posteriorly, gradually widening into the colon, and then, more or less abruptly, into the short, broad, bulbous-appearing rectum. The hind-intestine occupies about one-half of the alimentary tract.

THE HISTOLOGY OF THE ALIMENTARY TRACT

THE FORE-INTESTINE

A histological examination of the fore-intestine shows it to consist of the following tissues, the connective tissue, (often misnamed the peritoneal membrane), the circular muscles, the longitudinal muscles, the hypodermal cells, and the intima, (Plate I, Figs. 1 and 2); Plate II, Fig. 5).

The connective tissue is a very thin membranous-appearing layer of

cells, entirely surrounding the alimentary tract and its appendages. In the fore-intestine it retains its membranous appearance the entire length.

Immediately within the connective tissue is the layer of circular muscles, consisting of a relatively few fibers in the anterior portion of the oesophagus, (C M, Plate I, Fig. 2), to a layer four or five fibers in thickness around the gizzard, (C M, Plate I, Fig. 1), and the oesophageal valve, (C M, Plate II, Fig. 5).

Just within the layer of circular muscles are the longitudinal muscles, which nearly fill the folds of the intima in the anterior portion of the fore-intestine, (L M, Plate I, Figs. 1 and 2), and apparently are entirely absent at the oesophageal valve, (L M, Plate II, Fig. 5). These muscle fibers are relatively short.

At the base of the intima and lying next to the longitudinal muscles is the hypodermal tissue. In the fore-intestine these cells are relatively small, flattened, brick-like in appearance. Between this tissue and the muscle tissues is the basement membrane, which, however, could not be demonstrated in the fore-intestine, either in longitudinal or cross sections.

The intima, which lines the lumen of the fore-intestine, is secreted by the hypodermal cells and is homologous with the chitin of the body wall. However, it does not appear to be pigmented, with the exception of the oesophageal valve, and stains with fast green. The outer layer of primary intima stains a much deeper color than the inner or secondary intima. However there is no definite line of demarcation between the two layers, the color gradually increasing in intensity as the surface is approached. At the base of the oesophageal valve, the intimal layer, just prior to its end, shows projections of the base of the hypodermal cells into the secondary layer, (HYP, INT, Plate II, Fig. 5). Here the hypodermal cells are elongated and slender, projecting into the open space within the finger-like projection of the valve itself.

In the anterior portion of the oesophagus, the folds of the intima projecting into the lumen, are irregular in size, shape, and number, (INT, Plate I, Fig. 2). However in the gizzard, just anterior to the oesophageal valve, these folds assume a more or less definite and regular arrangement and shape, (INT, Plate I, Fig. 1). This consists of four folds, mushroom-shaped in cross section, of thick, heavy intima. Arising just above the base of these folds are two shorter folds, finger-like in cross section, one on each side. Between the large mushroom-shaped folds is one long finger-like fold.

A longitudinal section of the fore-intestine demonstrates a ringed or ridged characteristic structure of the surface of the intima of the posterior portion of the oesophagus and of the gizzard. From the summits of these ridges, spines of chitinous material project in a curved direction, mesad and caudad, into the lumen. These spines do not stain and are about equal in length to the thickness of the intima. As the oesophageal valve is approached, these spines become rapidly shorter, appearing as tooth-like ridges upon the throat of the valve and rapidly becoming obsolescent posteriorly, (INT, Plate II, Fig. 5). These spines appear also in the hind-intestine, immediately posterior to the entrance of the malpighian tubules into the lumen of the intestine, but they do not

occupy as extended an area, also the ringed character of the intima is entirely lacking in the hind-intestine.

Between the fore and mid-intestines, enclosed within the connective tissue, is a wedge-shaped collar of tissue, (F T, Plate II, Fig. 5). This tissue stains a deep green and the cell walls cannot be demonstrated. It appears filled with small globules of oil and is possibly a fatty tissue. It entirely surrounds the oesophageal valve.

THE MID-INTESTINE

The mid-intestine occupies the greater portion of the abdomen and in its entirety is of uniform appearance, both externally and histologically. Circular and longitudinal muscles may be present, but in very small numbers, and could not be identified in most of the sections. Surrounding the mid-intestine is the connective tissue, which is contiguous with that of both the fore and hind-intestines. The tissues within the connective tissue is chiefly composed of epithelial cells, whose function is the excretion of digestive fluids. This epithelial layer of cells is invaginated to form large folds of epithelial tissue, which project well into the lumen of the mid-intestine. At intervals along the basement membrane are located ovoid, dark-stained masses, which are probably the nidi from which the epithelial cells arise. (C T, EPI, NI, Plate I, Fig. 5; Plate III, Fig. 8). These epithelial cells are formed in definite groups, surrounded by a membrane. Around the inner or mesal edge of the epithelial tissue is another membrane, which is probably the peritrophic membrane or at least functions in that capacity. It follows closely the foldings of the epithelial tissue, and its origin could not be determined.

THE HIND-INTESTINE

At the posterior end of the mid-intestine, just prior to the first entrance of the malpighian tubules, is a layer of intima and hypodermal cells which have a "fluffy" appearance and project slightly into the lumen of the mid-intestine. This is the only indication of a pyloric valve. Here as in the finger-like projections of the oesophageal valve, the hypodermal cells are much elongated and slender, and they have projecting attachments to the secondary intima which stain a very deep green. The basement membrane is in decided evidence, and there are a few fibers of circular muscles present about the valve, (INT, HYP, C M, Plate III, Fig. 8).

The first point of entrance of the malpighian tubules is taken as the point of demarcation between the mid and hind-intestine, which is supported histologically by a decided differentiation between the tissues of each of the parts of the tract. The connective tissue, which is present as a thin membrane, anterior and posterior to this point, becomes much thickened, although definite cell separations and nuclei could not be demonstrated, and separates from the other enclosed tissues to form a separate surrounding envelope about the entrance of the tubules, (C T, Plate III, Fig. 6). Anteriorly from this point, along the tubules, the connective tissue once more becomes intimately associated with the tubules, (C T, Plate III, Fig. 7). Any extension of the intima of the hind-intestine and pyloric valve into the malpighian tubules could not

be shown. The extent and paths of the tubules in the body cavity could not be determined, as they became very brittle in the preserved material and were intertwined with the other tissues in the abdomen of the insect. However, they are evidently very extensive, as the body cavity was quite filled with the tubules.

Immediately posterior to the entrance of the tubules is the hind-intestine. The tissues of this part of the alimentary tract are very similar in appearance and location to those of the fore-intestine, substantiating the evidence that these portions of the alimentary tract are both of ectodermal origin, the chief difference noted being the relationship between the muscle tissues. In the fore-intestine the circular muscles entirely surrounded the longitudinal muscles, whereas in the hind-intestine, the longitudinal muscles are isolated strands of fibers located at more or less regular intervals outside the circular muscles.

The distal ends of the malpighian tubules re-enter the tract at a point about midway along the ileum. They do not penetrate into the lumen but remain just beneath the connective tissue that surrounds the digestive tract. Here they begin a series of convolutions and eventually form a complete sheath about the hind portion of the ileum and the entire colon, and fore-part of the rectum, (M T, Plate III, Fig. 9; Plate IV, Fig. 10). It was not determined whether the tubules divide, however they become much smaller, both the tubes and the cells composing them, and, either the tubes divide, or, they dwindle in size due to the convolutions, which occur in a very short distance, to form a complete layer of tubules about the tract. Just prior to the anus, the tubules end blindly in the space between the outer sheath of connective tissue and the circular muscles.

The longitudinal muscles are very small and few in number, and are located outside the circular muscles at points about equidistant about the digestive tract. They are most numerous just posterior to the pyloric valve, but can scarcely be demonstrated in the rectum. The longitudinal muscle fibers lie in constrictions of the circular muscles in each part of the hind-intestine although in the rectum these constrictions are scarcely evident.

The entire hind-intestine, with the exception of the posterior portion of the rectum, shows a well-developed circular muscle system. These muscles first appear just prior to the first entrance of malpighian tubules, (C M, M T, Plate III, Fig. 8), and surround the pyloric valve. In the forepart of the ileum they are a thick heavy layer of tissue and are "tied-in" at six points to the hypodermal layer. This same "Tieing-in" is apparent throughout the entire hind-intestine, but less noticeably so in the posterior portion of the rectum, (C M, Plate IV, Fig. 11). At each of these points the hypodermal layer and intima are in close association with the muscle layer. As the posterior portion of the ileum is approached, the thickness of the circular muscle tissue decreases notably. This decrease continues until in the colon only two or three very elongate fibers remain, and in the forepart of the rectum, only one fiber surrounds each portion of the tract, (C M, Plate IV, Fig. 10). From this point there is a sudden increase in the fibers to just prior to the anus, where the circular muscle tissue becomes many fibers thick, (C M, Plate IV, Fig. 11).

In contrast to the fore-intestine, the basement membrane in the hind-intestine is very evident its entire length.

The hypodermal layer of tissue is much more in evidence in this portion of the alimentary tract than in the fore-intestine. Here the cells are much larger and nearly square in outline. At the point where the hypodermal cells appear, just prior to the first entrance of the malpighian tubules, (HYP, Plate III, Fig. 8), the cells are much elongated and have dark-staining attachments to the secondary intima, as was noted in the oesophageal valve. In the ileum the cells of this tissue are much smaller and increase in size as the posterior part of the hind-intestine is approached, (HYP, Plate III, Fig. 9; Plate IV, Figs. 10 and 11). As these cells secrete the intima, they are very closely associated with it and lie in folds projecting into the lumen of the tube.

As stated previously, the intima shows the spiny character exhibited in the oesophagus and gizzard of the fore-intestine, but here the area is not as extended, (INT, Plate III, Fig. 8). There is no ringing or striation of the intima in the hind-intestine. The intima at the pyloric valve is of a "fluffy" appearance, which character is maintained for a short distance posteriorly. It is very thick at this point, gradually becoming less so as the narrower part of the ileum, (INT, Plate III, Fig. 9), is approached, and then becoming increasingly thick toward the rectum, (INT, Plate IV, Figs. 10 and 11). In the colon the intima is quite thick, and in the forepart of the rectum lies in pad-like arrangement, (INT, Plate IV, Fig. 10). There are six of these pads, whose delineations, however are shown only by the attachment of the circular muscle fibers and the thinning of the intima at these points. In the posterior portion of the rectum, the intima projects into the lumen in numerous folds, which nearly fill the lumen of the rectum, (INT, Plate IV, Fig. 11.) Anterior to the rectal pads, the folds of the intima nearly fill the lumen of the tube, becoming gradually less elongate until a short distance posterior to the pyloric valve, where they become more nearly as in the anterior portion of the rectum.

SUMMARY

This paper is a study of the morphology and histology of the alimentary tract of the blister beetle, *Epicauta cinerea* Forst., variety *marginata* Fab., collected in southeastern Ohio.

The fore-intestine consists of the oseophagus, gizzard, and oesophageal valve. The latter is highly developed, consisting of four finger-like projections, which extend into the mid-intestine about one-fifth its length.

The mid-intestine lacks any well-developed muscle tissues. The epithelial tissue is invaginated to form folds, which project well into the lumen of the intestine. This tissue possibly forms the peritropic membrane.

Just prior to the entrance of the malpighian tubules, there is a ring of circular muscles. At this point the intima and

hypodermal cells project slightly into the lumen of the tract. This is the only indication of a pyloric valve.

The hind-intestine consists of the ileum, the colon, and the rectum. The circular muscles are well-developed in the ileum, and posterior portion of the rectum. In the colon and anterior portion of the rectum, they consist of only one or two strands. The longitudinal muscles are few in number, and arranged in groups of six, approximately equi-distant about the circular muscles, which exhibit a "tieing-in" at these points.

The malpighian tubules are six in number and enter the tract at two points, just posterior to the pyloric valve, where they penetrate into the lumen of the alimentary tract, and midway of the ileum, where they remain beneath the connective tissue, and through increasing convolutions and decreasing size form a sheath of small tubules about the posterior portion of the hind-intestine.

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ABBREVIATIONS USED ON PLATES

B M—Basement Membrane.
C M—Circular Muscles.
COL—Colon.
C T—Connective Tissue.
EPI—Epithelial Tissue.
F T—Fat Tissue.
GIZ—Gizzard
HYP—Hypodermal Tissue.
ILL—Ileum.
INT—Intima.
L M—Longitudinal Muscles.
LU—Lumen.
MI—Mid-intestine.
M T—Malpighian Tubules.
NI—Nidus.
OES—Oesophagus.
O V—Oesophageal Valve.
P V—Pyloric Valve.
REC—Rectum.

EXPLANATION OF PLATES

Plate I

Fig. 1. Cross section through the gizzard.
Fig. 2. Cross section through the oesophagus.
Fig. 3. Dorsal view showing the gross dissection of the alimentary tract.

Plate II

Fig. 4. Gross drawing of one of the finger-like projections of the oesophageal valve.
Fig. 5. Longitudinal section through the oesophageal valve, showing the posterior portion of the oesophagus, the gizzard, and the anterior portion of the mid-intestine.

Plate III

Fig. 6. Cross section through a malpighian tubule just prior to first entrance into the alimentary tract at the pyloric valve, showing the surrounding envelope of connective tissue.
Fig. 7. Cross section through a malpighian tubule in the body cavity.
Fig. 8. Longitudinal section through the pyloric valve, showing the posterior portion of the mid-intestine, the entrance of the malpighian tubules into the lumen of the alimentary tract, and the anterior portion of the ileum.
Fig. 9. Cross section through the ileum immediately posterior to the second entrance of the malpighian tubules into the alimentary tract, showing the tubules beneath the connective tissue.

Plate IV

Fig. 10. Cross section through the anterior portion of the rectum, showing the surrounding envelope of malpighian tubules immediately beneath the connective tissue.
Fig. 11. Cross section through the posterior portion of the rectum.

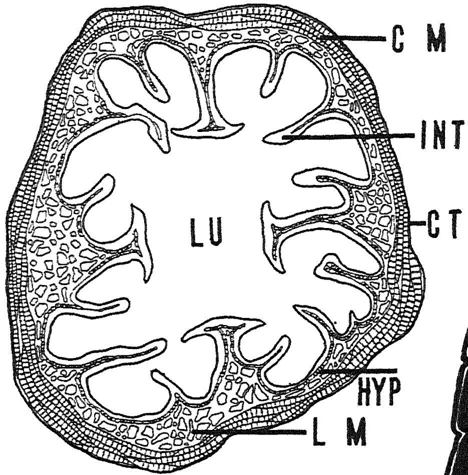


FIG 1

FIG 2

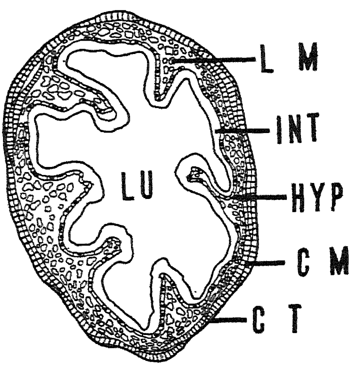
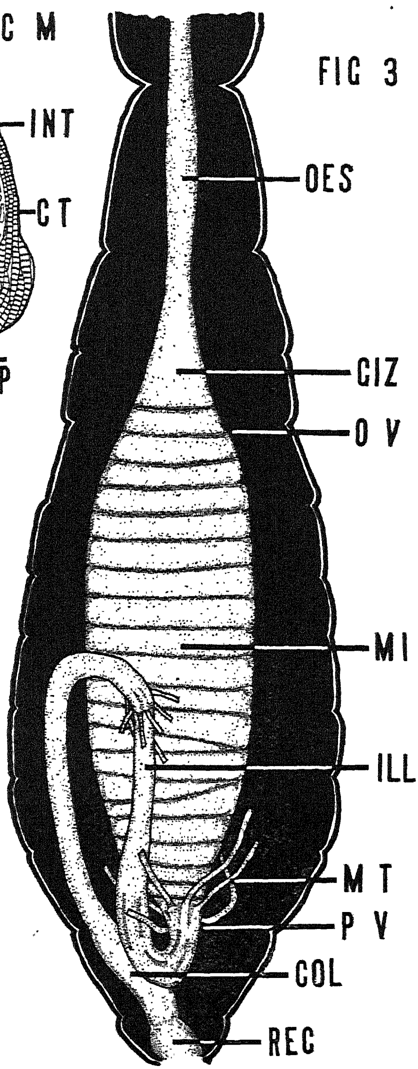


FIG 3



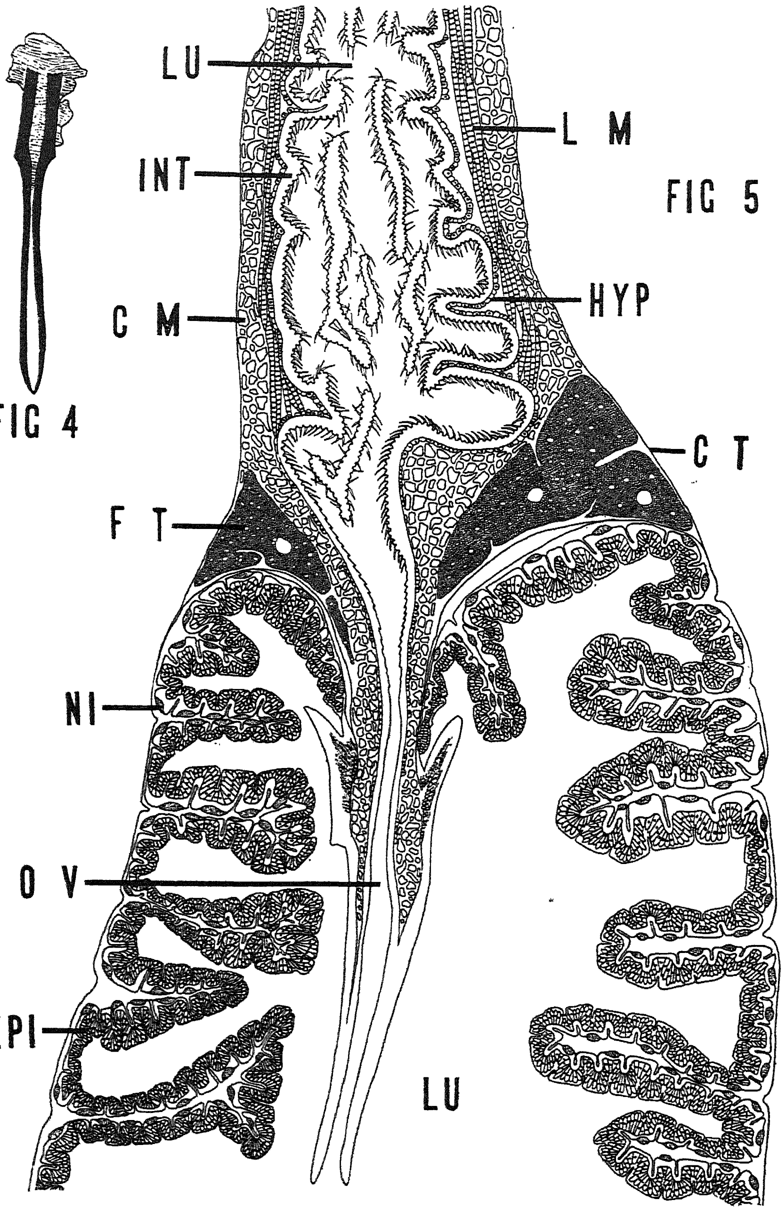


FIG 4

FIG 5

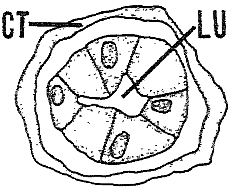


FIG 6

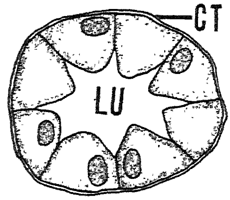


FIG 7

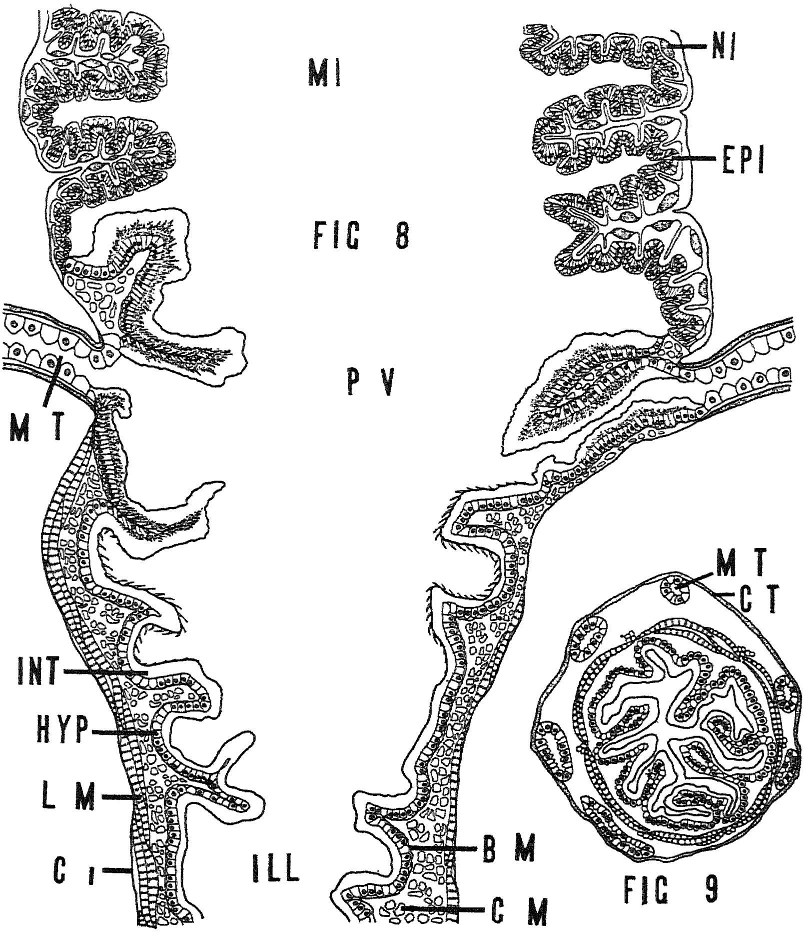


FIG 8

FIG 9

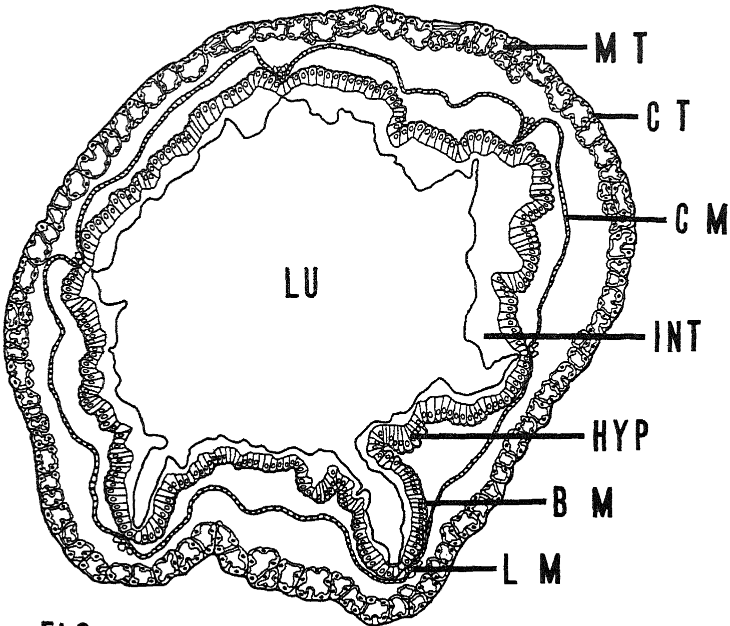


FIG 10

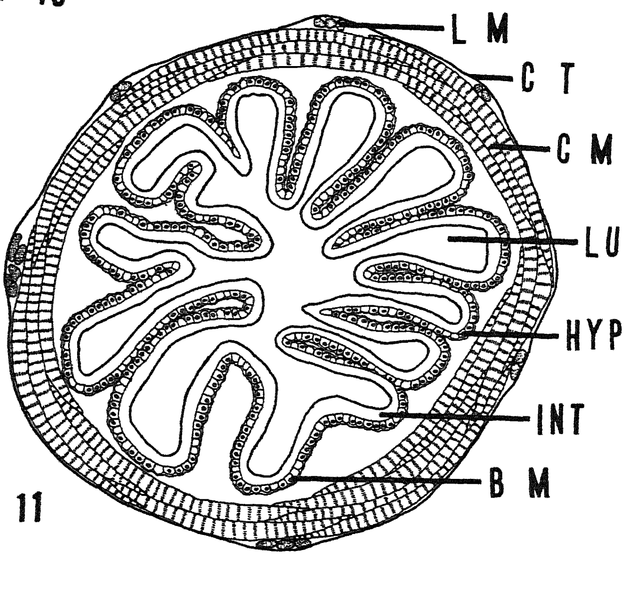


FIG 11

SOME NEW GENERA OF LEAFHOPPERS RELATED TO THAMNOTETTIX

DWIGHT M. DeLONG
Ohio State University

In a recent paper Dr. E. D. Ball[1] has described several new genera of species formerly included in *Thamnotettix*. Others from the same group are described herewith, especially genera containing grass feeding species. A synopsis of each of the genera described below is now in manuscript form and will appear separately together with illustrations of the species characters of each genus.

Genus **Ballana** DeLong, nov.

Resembling *Gloridonus* Ball but more robust, with broader head and usually larger in size. Vertex usually bluntly, sometimes rather sharply angled, margin usually thick. Venation similar to *Gloridonus*, elytra usually broad, apical cells short. Male oedagus long and slender one side bearing teeth, the other side without. Male ninth segment with two pairs of dorsal spines which may be single or bifurcate.

Type of genus *Thamnotettix vetula* Ball.

This genus comprises the *atridorsum* series including the vetula, vespertina, vivata and visalia group described by Ball and since he described most of the species now named in this genus I take pleasure in dedicating it to him. All of these are western species and occur on *Chrysothamnus*, other shrubs and some herbaceous plants. Their habitat is the desert areas of the western United States.

Subgenus **Viriosana** DeLong, nov.

Closely related to *Ballana* and with similar genital structures but with vertex very blunt and rounded. Vertex only slightly longer at middle than next the eyes, margin thick and rounded to front, broadly rounded between eyes.

Type of subgenus *viriosa* Ball.

Subgenus **Laterana** DeLong, nov.

Closely related to *Ballana* but larger and more robust, vertex broadly bluntly angled, apex bluntly pointed, vertex flat, margin acutely angled with front. Male ninth segment differing from *Ballana* in having a pair of spines directed inwardly, arising from the basal arm between the anterior and posterior pairs of spines as found in *Ballana*.

Type of subgenus *dissimilata* Ball.

[1]Bul. Brook. Ent. Soc., 31: 57, April, 1936.

Genus **Elymana** DeLong, nov.

Long, slender, pointed headed species resembling *Gloridonus* Ball. Vertex sharply jointed and acutely angled with front. Elytra long and narrow. Venation as in *Thamnotettix*. Ninth segment of male long, tapering to a pointed spine like process. Oedagus long tapering to a long slender, dorsally directed process. Female segment truncate.

Type of genus *Thamnotettix inornatus* Van Duzee.

The species of this genus are closely related and are usually found in woody areas on Elymus and related grasses. They are probably closely related to certain species of the genus *Laevicephalus* DeLong.

Genus **Cyperana** DeLong, nov.

Related to *Elymana* but with vertex rounded and bluntly angled, not strongly produced, bluntly angled with face margin thick. Usually some shade of green or yellow with a black band or a row of black spots on margin of vertex. Elytra long and narrow, venation of *Thamnotettix* type.

Type of genus *Thamnotettix melanogaster* Prov.

The species belonging to this genus occur in the fresh water marsh on sedges of the Cyperus group. Most of these occur in the eastern United States.

Genus **Graminella** DeLong, nov.

Resembling and apparently intermediate between *Laevicephalus* on the one hand and *Deltocephalus* on the other. Vertex usually produced but bluntly angled, margin thick venation simple but with second anteapical cell long and constricted at middle. This causes the second apical cell to be very short comparatively.

Type of genus *Thamnotettix aureovittatus* Sanders and DeLong.

The species of this genus are all grass feeders so far as is known and are common on the fresh and salt water marshes of the eastern United States, occurring especially on the grasses of the Spartina association. Certain species also occur on the wet and dry prairies of Illinois and other middle western states.

Genus **Calana** DeLong, nov.

Allied to *Graminella* but differing by having a more pointed head and with a rather definite margin on vertex which is accentuated by a marginal line. Vertex angularly produced, length equalling basal width between eyes, almost flat, acutely angled with front. Elytra with venation as in *Graminella* with second anteapical cell rather long and constricted at middle. It differs however in having the first anteapical cell almost as long as second, narrow, with a marginal vein to costa anterior to middle. Genitalia entirely different in form from the type found in *Graminella*. In lateral view the male oedagus is broadly U-shaped and the posterior portion bears a pair of lateral processes near the apex.

Type of genus *Thamnotettix umbricatus* Ball.

Genus **Deltocephalus** Burm.

Subgenus **Unerus** DeLong, nov.

Closely related to *Deltocephalus* and with the same type of genital structures but differing by having one cross vein between the two sectors instead of two as found in *Deltocephalus*. Vertex bluntly angled, rounded to front, without prominent margin.

Type of subgenus *Thamnotettix colonus* Uhler.

To this group also belongs *nigrifrons* Forbes. Both species are certainly closely allied to *Deltocephalus* in every way but lack one of the two cross veins which characterizes the species of that genus.

Ancient Artizans

There is available a large amount of interesting information which concerns insects and their relations to human society. Much of this information is in scientific journals and periodicals beyond the reach of the ordinary reader. Dr. Frost has gathered many of these interesting bits of information from the scientific literature and has brought them together into this very interesting volume. The presentation is of a popular nature and should appeal to the layman. The book should also be very helpful to nature lovers and to teachers of biology in high schools, and for beginning courses in entomology it will serve as excellent supplementary reading.

There are seventeen chapters which are given headings as follows: I, Introduction; II, Foragers, Wanderers, Nomads, Hunters; III, Agriculturalists; IV, Masons; V, Carpenters; VI, Spinners, Weavers, Tailors, Lace Makers; VII, Miners; VIII, Aviators; IX, Paper Makers; X, Divers; XI, Wax Workers; XII, Garbage Collectors; XIII, Musicians; XIV, Assassins; XV, Miscellaneous Artizans; XVI, Fishermen; XVII, Death, Sleep, Death Feigning, Hibernation. Numerous references are given at the end of each chapter in case the reader desires more information on a particular subject. An index is included at the end of the book. Scientific names are given at the bottom of each page on which a particular insect species is discussed.

The illustrations have been taken from the literature and many of them are not the best that may be found in some of the scientific journals. The book is well bound and printed on good paper.—R. H. Davidson.

Ancient Artizans, by Stuart Ward Frost. 295 pp. Boston, The Van Press, 1936. $3.50.

Human Biology

The author of "Genetics and the Social Order," which was reviewed in a recent number of this journal, has attacked the broader problem of human behavior with the same keen insight, clarity of presentation, and stimulating suggestions which characterized his earlier book. The volume opens with several well-written chapters about the forces of the environment and their interaction with the genetic make-up of the animal. Then follow a series of chapters on cells, heredity, mutation and evolution. The final two chapters deal with human behavior in general, and racial and social behavior in particular. The author adheres scrupulously to the scientific method, rejecting all guess-work, wishful thinking and unfounded opinions, holding only to that which is known or may reasonably be assumed on scientific grounds. As in his previous book, he attacks eugenic propaganda, but the student of human genetics will be forced to agree with him in most of his conclusions. The book is highly recommended to biologist and layman alike.—L. H. S.

Biology and Human Behavior, by Mark Graubard. 413 pp. New York, Tomorrow Publishers (303 Fourth Ave.), 1936. $2.50.

SEVEN NEW SPECIES OF THE GENUS APHALARA (HOMOPTERA: CHERMIDAE)

JOHN S. CALDWELL
Ohio State University

Aphalara constricta n. sp.

Length to tip of forewing 3.–4. mm.; forewing 2.–3. mm.

Color: Greenish yellow.

Vertex two-thirds as broad as long, scarcely wider than pronotum; notch at end of median line slight, rounded. Foveal impressions very broad, shallow. Antennae as long as width of head.

Thorax robust, strongly arched. Forewing two and half times as long as broad. Veins yellow, conspicuously raised; membrane hyaline, coriacious. Cu_1 scarcely arched.

Genitalia: Male genital plate much elongated. Proctiger shorter than forceps; lobes longer than plate, caudal two-thirds with margins subparallel in lateral apsect, apices rounded. Forceps long, slightly broader at apex than base; margins sinuate in lateral aspect; apices very broadly rounded. Oedeagus with anteriorly directed hook apically.

Female genitalia as long as rest of abdomen; both ventral and dorsal valves styliform for caudal half; dorsal valve more so than ventral. Dorsum of caudal half of dorsal valve finely serrate.

Male holotype, female allotype, and two female paratypes from Hereford, Ariz., July 28, 1907, with no collector label are in the H. Osborn collection, Ohio State University. One female paratype from American Falls, Ida., 6–25–30, and one female paratype from Murtauch, Ida., 6–21–30, both collected by D. M. DeLong are in the DeLong collection at Ohio State University.

Aphalara osborni n. sp.

Length to tip of forewing 2.75–3. mm.; forewing 2.–2.5 mm.

Color: Pale yellow to pale green; thorax marked with yellow.

Head usually strongly deflexed, a little over twice as broad as long. Vertex two-thirds as long as broad; foveal impressions small, shallow. Antennae longer than width of head.

General build much less robust than *constricta*. Thorax strongly arched, not unusually broad. Wings resembling *constricta* but differing as follows: more yellowish, less rugose; Cu_1 strongly arched, shorter.

Genitalia: Male genital plate very large. Proctiger as long as forceps; lobes as long as plate, widely attached at base; ventral margins narrowed from ventral hook to acute apices. Forceps broad at bases and apices; cephalic margins greatly concave midlength; caudal margins straight for basal half thence rounded cephalad to broad apices.

Female genital segment about as long as rest of abdomen. Dorsum of dorsal valve straight to within four-fifths of apex thence narrowed ventrally to a blunt apex. Ventral valve narrowed on dorsal margins for apical half.

Male holotype, female allotype, and two female paratypes collected by Dr. H. Osborn at Pueblo, Colo. date unknown, are in the H. Osborn collection. One male and two female paratypes collected by Dr. D. M. DeLong at Sardine Canyon, Ut., 7–22–33, are in the DeLong collection.

The writer takes great pleasure in naming this species in honor of Dr. Herbert Osborn who has made it possible for him to work on the chermids.

Aphalara delongi n. sp.

Length to tip of forewing 3.–3.5 mm.; forewing 2.5–3 mm.

Color: Greenish yellow marked with straw yellow on thorax.

Head wider than pronotum, at least as wide as broadest part of thorax, two and a half times as broad as long. Vertex two-thirds as long as broad; notch at end of median line sharp, deep. Antennae one and a half times as long as width of head.

Thorax scarcely arched. Forewings two and a half times as long as broad, rugose, hyaline; veins yellow, raised; cell formed by long branch of cubitus, long, broad.

Genitalia: Male genital plate extremely large. Proctiger short; lobes shorter than plate, with acutely pointed apices. Forceps longer than proctiger, of equal width to apices; anterior-mesal process prominent, not concealed by forceps in lateral aspect.

Female genital segment shorter than rest of abdomen. Middle third of dorsal valve elevated. Ventral valve with caudal third of dorsal margins narrowed.

Male holotype from Northeast, Pa., 6–17–19, collected by D. M. DeLong. Female allotype from Charter Oak, Pa., 7–11–17, collected by H. B. Kirk. Twenty-one male and female paratypes from Charter Oak, Speechville, Harrisburg, Conewago, and Foxburg, Pa., collected during June and July by J. G. Sanders, H. B. Kirk, and D. M. DeLong. All types are in the DeLong collection.

The writer takes great pleasure in naming this species in honor of his teacher and advisor, Dr. Dwight M. DeLong.

Aphalara furcata n. sp.

Length to tip of forewing 2.5–3. mm.; forewing 2.–2.5 mm.

Color: Vertex yellow; thorax yellowish green; abdomen green.

Head over twice as broad as long, as wide as thorax. Vertex two-thirds as long as broad; notch at end of median line shallow. Foveal impressions rather large, deep. Eyes very prominent. Antennae one and a half times as long as width of head.

Thorax not broad, moderatley arched. Forewings slightly over twice as long as broad; longer in female than male. Cu_1 scarcely arched forming almost triangular marginal cell.

Genitalia: Male genital plate as long as broad in lateral aspect. Lobes of procitger longer than plate, narrow for full length; apices broadly rounded. Forceps longer than proctiger; basal half straight, narrow; apical half curved cephalad, enlarged on cephalic margin.

Female genital segment shorter than rest of abdomen. Ventral valve much shorter than dorsal, narrow; apex with shallow notch.

Holotype male from Northeast, Pa., 6–17–19, collected by D. M. DeLong. Allotype female collected by J. G. Sanders at Allenhurst, Pa., 6–20–19. Fifty male and female paratypes collected in June and July by D. M. DeLong, J. G. Sanders, and J. N. Knull, at North Bloomfield, Duncannon, Harrisburg, Pt. Royal, Charter Oak, Allenhurst, and Speechville, Pa., and Battle Pt., Va. These are in the DeLong collection. One female paratype is in the H. Osborn collection from Sault Ste. Marie, Ontario, 1904, no collector label present.

Aphalara bifida n. sp.

Length to tip of forewing 2.5–2.75 mm.; forewing 2. mm.

Color: Vertex yellow; thorax and abdomen greenish yellow; thorax with four more or less distinct longitudinal green stripes.

Resembling *furcata* but differing as follows: Vertex proportionally shorter; notch at end of median line shallower; foveal impressions less distinct. General build less robust. Thorax less arched. Forewings very flaveous; cubital cell longer, narrower. Dorsal valve of female genital segment shorter, straighter. Ventral valve with deeper notch at apex. Whole genital segment more thickly beset with small setae.

Male unknown.

Female holotype and two female paratypes from Miami, Fla., 1–24–34, collected by the author are in his collection.

Aphalara hebecephala n. sp.

Length to tip of forewing 3. mm.; forewing 2.5 mm.

Color: Appearing pale green; praescutum straw yellow.

Head three times as broad as long, much wider than pronotum. Vertex over one-third as long as broad, scarcely produced beyond cephalic margins of eyes; foveal impressions large, shallow. Eyes very prominent. The antennae are missing on all specimens.

Thorax scarcely arched. Forewings scarcely twice as long as broad; Cu_1 greatly arched.

Genitalia: Male genital plate small. Proctiger long; lobes large, much longer than plate. Forceps short, bifed; basal portion short, straight; caudal lobe long, acuminate; anterior lobe short, straight, directed dorsad. Oedeagus with abrupt knob-like apex; small hook apically on anterior margin.

Female genitalia with dorsal valve shorter than ventral; apex bifed.

Described from one male and two females collected by C. J. Drake, 6–5–17, Cranberry Lake, N. Y. Male holotype, female allotype, and female paratype are in the H. Osborn collection.

Aphalara sinuata n. sp.

Length to tip of forewing 2.5 mm.; forewing 2. mm.

Color: Solid greenish yellow.

Head less than twice as broad as long, as wide as thorax. Vertex flat; notch at end of median line shallow, rounded. Antennae missing.

Thorax strongly arched, not broad. Forewing over two and a half times as long as broad, transparent. Cell formed by long branch of cubitus broad.

Genitalia: Male genital plate very large, much longer than broad in lateral aspect. Proctiger short; lobes shorter than genital plate, margins sinuate, apical third gently narrowed. Forceps with basal two-thirds bulging caudad, thence constricted with apical third bulging again roundedly to caudal apical point; cephalic margins gently concave, rounded apically to the caudal apical point in lateral aspect.

Female unknown.

Described from one male collected by G. I. Reeve at Tower City, N. Dakota. Male holotype is in the H. Osborn collection.

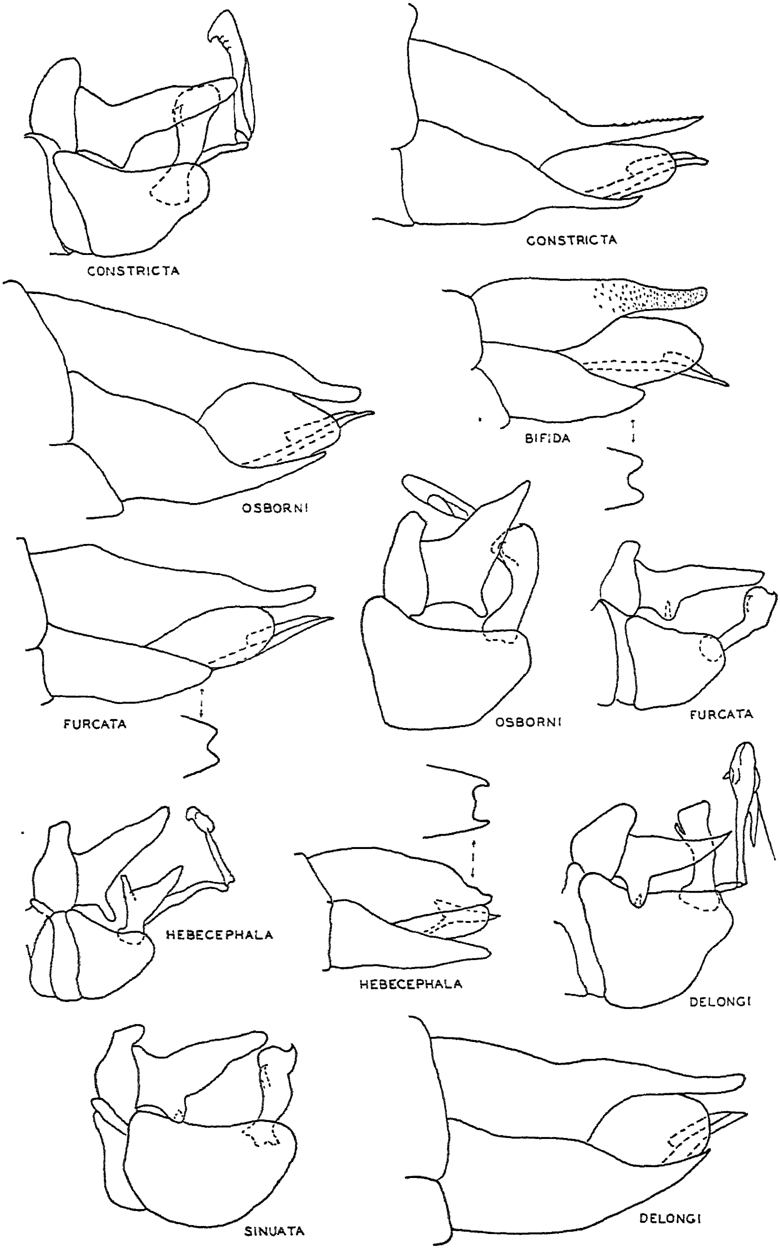


FIG. 1. Lateral View of Male and Female Genitalia.

FURTHER STUDIES OF THE GENUS EMPOASCA.[1] (HOMOPTERA, CICADELLIDAE.)

PART IV

ELEVEN NEW SPECIES OF *Empoasca* FROM THE UNITED STATES

DWIGHT M. DELONG
AND
RALPH H. DAVIDSON,
Ohio State University

Empoasca gelbata n. sp.

Resembling *obtusa* in general appearance but with distinct genitalia. Length, 4 mm.

Vertex broadly rounded, slightly produced at middle, almost parallel margined.

Color: Dull yellowish to greenish yellow, tinged with brown.

Genitalia: Female last ventral segment strongly, roundedly, produced, becoming somewhat pointed at apex. Male plates rather short, gradually tapering to blunt apices. Lateral processes of pygofers in ventral view slightly narrowed near apex, the inner margin curving outwardly at apex. In lateral view the processes are notched dorsally near apex, and concavely excavated ventrally beyond this notch. Spine of ninth segment sickle-shaped, the apical half narrower, with apex extending almost ventrally.

Described from a male specimen collected at Fish Lake, Wisconsin, August 15, 1924; and four male and four female specimens collected October 11, 1919, at Ames, Iowa, and one female collected at Madison, Wisconsin, July 29, 1917. The specimens from Ames, Iowa and Madison, Wisconsin, were collected by Dr. E. D. Ball. Male holotype from Fish Lake, Wisconsin, and female paratypes from Ames, Iowa, and Madison, Wisconsin, in DeLong collection. Female allotype and male and female paratypes from Ames, Iowa, in Ball collection.

Empoasca gleditsia n. sp.

In form and general appearance this species resembles *pergandei*, but with distinct genitalia. Length 3.5 mm.

Vertex broadly rounded, scarcely produced, parallel margined, twice as wide between eyes as median length.

Color: Green tinged with yellow. Elytra subhyaline, veins paler, a black spot just anterior to each posterior cross vein.

Genitalia: Female last ventral segment roundedly produced, bearing a rather deep narrow notch at apex which is rounded at base. Male plates long and rather narrow. Lateral processes of the pygofer in lat-

[1]Previous studies of this group are summarized in OHIO JOURNAL OF SCIENCE 35: 29, January, 1936.

eral view enlarged and bent upward just before apical portion which is slender and curved slightly caudally. In lateral view these processes are narrowed and curved inwardly at apex. Spine of ninth segment short and broad with an anterior, ventrally pointed projection.

Described from a series of nine male and female specimens collected at Twin Falls, Idaho, June 23, 1932, from Globe Locust. Male holotype, female allotype and male and female paratypes in DeLong collection.

Empoasca chelata n. sp.

Resembling *bifurcata* in general appearance but with distinct genitalia. Length 3 mm.

Vertex produced and bluntly angled, one-fourth wider between eyes than length at middle.

Color: Bright green tinged with orange.

Genitalia: Female last ventral segment roundedly produced. Male plates long and tapered to blunt apices. Lateral processes of pygofers bifurcate at apex forming a chela. Spines of ninth segment short and broad, broadly concavely rounded on anterior margin forming a ventrally, anteriorly directed spine.

Described from two specimens collected at Okolona, Mississippi, June 14, 1934, from *Crateagus* by Mr. D. W. Grimes. Male holotype, female allotype, in DeLong collection.

Empoasca setata n. sp.

In form and general appearance resembling *Forcipata fieberi*. Closely related to *erigeron* but with distinct genitalia. Length 3.5 mm.

Vertex strongly produced, bluntly angled, one-third wider between eyes than length at middle.

Color: Yellow tinged with orange, anterior margin of pronotum with three pale spots one at middle and one behind either eye.

Genitalia: Male plates long, concavely curving on outer margin, apices broadly curved and slightly enlarged. Lateral processes of pygofers in ventral view tapering to pointed apices, usually crossed before apex. In lateral view they taper to a pointed apex which is slightly deflected. Spine of ninth segment short and broad, deeply notched anteriorly to produce a long narrow apical portion directed anteriorly.

Described from a single male specimen from Santa Fe, Mexico, collected in October, 1898. Male holotype in DeLong collection.

Empoasca rubrata n. sp.

Form and general appearance of *aureoviridis* but with distinct genitalia. Length 4.5-5 mm.

Vertex broadly rounded, more than twice as broad as length at middle.

Color: Brown, tinged with dull reddish. Elytra smoky, veins brownish. Vertex, pronotum and scutellum sometimes entirely reddish.

Genitalia: Last ventral segment of female strongly roundedly produced, slightly broadly notched at apex. Male plates narrowed to blunt

apices. Lateral processes of pygofers in ventral view curving inwardly on apical half, enlarged by inward bulge just before rapidly narrowed, pointed apex. Slightly indented on outer margin opposite bulge. In lateral view the lateral processes are concavely excavated on ventral portion of apex which is very narrow and sharply pointed. Spine of ninth segment modified sickle-shaped, apical half narrow.

Described from a series of one male and four female specimens collected at Fish Lake, Utah, September 2, 1930, by the senior author; a male and two female specimens from the same locality collected August 16, 1929, by Dr. R. H. Beamer, and a male from Toas County, New Mexico, collected August 20, 1927, by Dr. R. H. Beamer; two male specimens collected at an altitude of 8,000 feet in Rincon Mountains, Arizona, July 5, 1916, by A. A. Nichol; one male from Newaygo, Canada, collected July 30, 1929; and one male from Phillips, Wisconsin, collected July 18, 1932. All except the specimens from Fish Lake collected by the senior author are in the University of Kansas collection. The following specimens are in the collection of Dr. E. D. Ball: One male from Little Beaver, Colorado, July 19, 1898, and one male and two females from Ames, Iowa, collected July 12, 1898. The Herbert Osborn collection has a series of males and females from Cranberry Lake, New York, collected in August, 1920.

Male holotype, female allotype, and male and female paratypes from Fish Lake, Utah, deposited in the DeLong collection. Male and female paratypes in Herbert Osborn collection; Snow collection, University of Kansas; and Ball collection.

Empoasca jacinta n. sp.

In form resembling *obtusa* but with distinct genitalia. Length 4 mm.

Vertex broadly rounded, scarcely produced, more than twice as wide as long.

Color: Green tinged with yellow.

Genitalia: Female last ventral segment strongly roundedly produced. Male plates long, rather uniform in width, rounded at apex. Lateral processes of pygofers in lateral view with apex narrowed and tapering to pointed tip. In ventral view they are very slender, enlarged near apex and curving outwardly, the inner margin concavely rounding, the apex pointed and directed inwardly. Spine of ninth segment sickle-shaped.

Described from a series of twelve male and female specimens collected at San Jacinto Mountains, California, July 15, 1930, by Mr. D. G. Hall. Male holotype, female allotype and male and female paratypes in Snow Entomological Collection, University of Kansas. Male and female paratype in the DeLong collection.

Empoasca ziona n. sp.

Resembling *obtusa* in general appearance but with distinct genitalia. Length 3.5 mm.

Vertex broadly rounded, scarcely produced, twice as wide as long.

Color: Dull green tinged with brown. Anterior margin of pronotum with white spots.

Genitalia: Female last ventral segment slightly, roundingly produced. Male plates long, tapered to blunt apices. Lateral processes of pygofers in ventral view long, tapering rather abruptly, constricted and curved inwardly just before apex. Spine of ninth segment long, strongly sickle-shaped, gradually tapered to sharp pointed apex.

Described from a pair of specimens collected at Zion National Park, Utah, August 12, 1929, by Paul W. Oman; and a series of twenty-eight male and female specimens from San Jacinto Mountains, California, collected in October, 1929, by D. G. Hall. Male holotype, female allotype, and male and female paratypes in Snow Entomological Collection, University of Kansas. Male and female paratypes in the DeLong collection.

Empoasca apata n. sp.

Resembling *atrolabes* in general appearance but with distinct genitalia. Length 3.7 mm.

Head narrower than pronotum, almost parallel margined.

Color: Dull green tinged with yellow. Elytra with claval suture pale, a large black spot anterior to last cross vein. Face black.

Genitalia: Male plates rather long and narrow. Lateral processes of pygofers long with rather slender apices concave on inner margin. The outer margin is produced and curved inwardly forming pointed tips. In lateral view the apex is concavely narrowed on ventral margin to sharp pointed tip. Spine on ninth segment rather short, apical half narrower, curved caudally and pointed at apex.

Described from two male specimens, one collected at Logan Canyon, Utah, July 24, 1930, by the senior author and one at Dixie, Oregon, July 8, 1931, by Dr. R. H. Beamer. Male holotype (Utah) in DeLong collection. Paratype male in Snow collection, University of Kansas.

Empoasca grosata n. sp.

Resembling *aureoviridis* in form and general appearance but with distinct genitalia. Length 5 mm.

Vertex broadly rounded, parallel margined, three times as wide as length at middle.

Color: Golden yellow tinged with brown.

Genitalia: Male plates long, tapering to blunt apices. Lateral processes of the pygofers in lateral view appearing distinctly notched both dorsally and ventrally so as to form a curving apex which is narrowed and sharply pointed. In ventral view they are enlarged near apex by a bulge on outer margin, then tapered to pointed apices. Spine of ninth segment sickle-shaped, the pointed apex extending farther anteriorly than base.

Described from a male specimen collected at Redfish Lake, Idaho, August 3, 1930, by the senior author; one male from Cedar City, Utah, collected August 13, 1929, by Dr. R. H. Beamer, and one male from Manitou, Colorado, collected by E. S. Tucker at an altitude of 6,629 feet.

Male holotype in DeLong collection. Male paratypes in Snow collection, University of Kansas.

Empoasca confusa n. sp.

In form resembling *alboneura* but apparently more closely related to *obtusa* group. Length 3 mm.

Vertex bluntly angled and slightly produced, about twice as wide between eyes as length at middle.

Color: Dull green, mottled with white. The vertex has three longitudinal whitish areas, the pronotum a median longitudinal whitish area, and behind each eye is a large blotch of white. Scutellum with a large, median, longitudinal white area. Elytra smoky, veins paler.

Genitalia: Male plates long, almost uniform in width, apices bluntly rounded. Lateral processes of pygofers in ventral view somewhat vermiculate, apices converging, rapidly narrowed on outer margin to pointed tips. In lateral view they are enlarged just before a rather slender apical portion. Spine of ninth segment short, broad, concave on anterior margin, forming a short thick tooth directed anteriorly.

Described from a single male specimen collected at Burns, Oregon, August 3, 1927. Holotype male in DeLong collection.

Empoasca carsona n. sp.

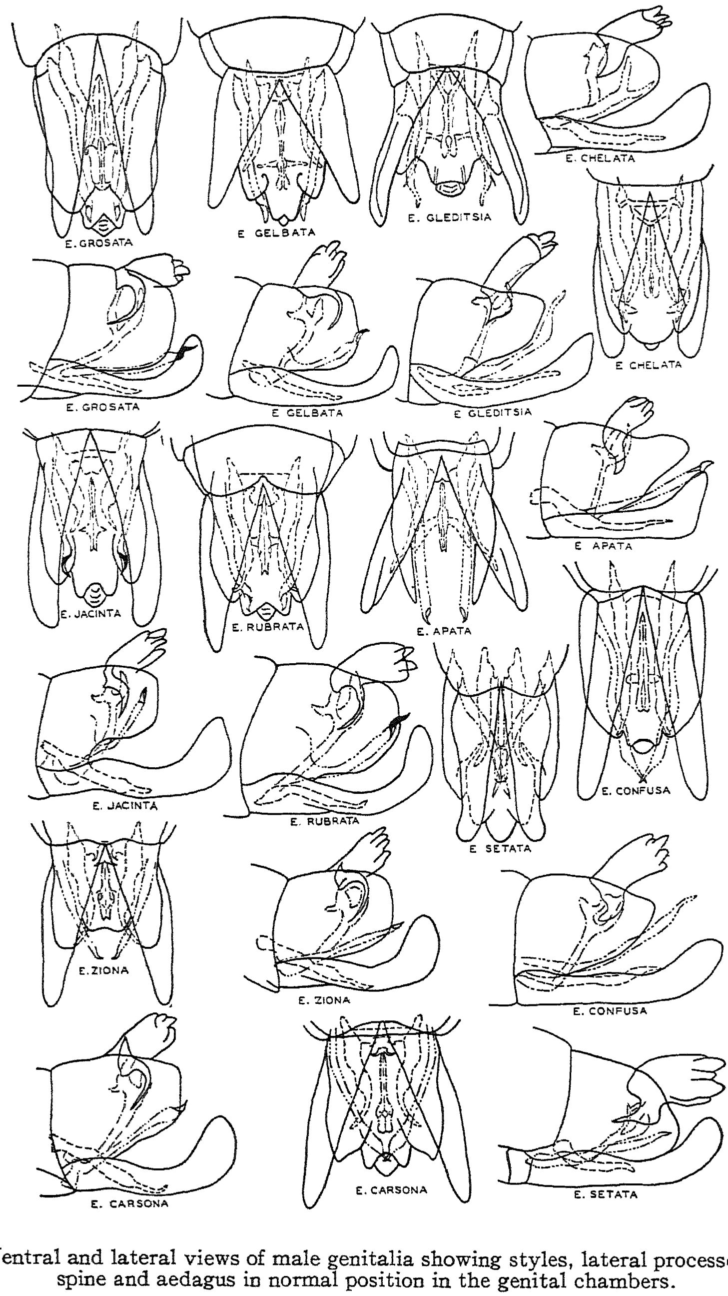
Resembling *obtusa* in form and general appearance but with distinct genitalia. Length 4–5 mm.

Vertex broadly rounded, slightly produced, twice as wide between eyes as length at middle.

Color: Green, tinged with yellow, three conspicuous white spots on vertex and three on pronotum. Elytra greenish subhyaline.

Genitalia: Female last ventral segment strongly produced and roundedly angled. Male plates rather long and narrow, tapered to blunt apices. Lateral processes of pygofers enlarged just before short and very narrow apices. In lateral view the dorsal margin of apical portion is concave. Spine of ninth segment sickle-shaped with narrowed apex directed downwardly.

Described from a series of 5 male and 28 female specimens. Four males and 21 females collected at Carson City, Nevada, August 9, 1929, by Paul W. Oman, and a male and seven female specimens collected at Maricopa County, Arizona, August 7, 1927, by Dr. R. H. Beamer. Male holotype and female allotype from Carson City, Nevada, and male and female paratypes in Snow collection, University of Kansas. Male and female paratypes in DeLong collection.



Ventral and lateral views of male genitalia showing styles, lateral processes, spine and aedagus in normal position in the genital chambers.

STUDIES IN HUMAN INHERITANCE XV

The Bimodality of the Threshold Curve for the Taste of Phenyl-thio-carbamide

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AND

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It has been shown by Snyder (1931, 1932), and Blakeslee and Salmon (1932) that the taste deficiency for phenyl-thio-carbamide (P. T. C.) is inherited as an autosomal recessive. Later Blakeslee (1932) showed that a wide variation exists in acuity of taste discrimination for the substance. He pointed out that persons who are non-tasters of the crystals can taste a saturated solution. The thresholds of those who are tasters of the crystals cover a wide range of dilutions.

It becomes important to determine whether the curve of thresholds involving both tasters and non-tasters of the crystals is actually bimodal. Do tasters and non-tasters represent one variable population, or can they be accurately separated on the basis of threshold tests?

To determine this point 584 persons were carefully tested for threshold. Of these 477 were white individuals and 107 were negroes. Of the whites, 85 were non-tasters of the crystals, while of the negroes only 8 were non-tasters.

For the thresholds tests a stock solution was made by dissolving .1 gram of P. T. C. in 99.9 cc. of distilled water. Since P. T. C. is only .26% soluble in water, this stock solution was allowed to stand overnight or was heated to 45° C. to obtain complete dissolution before it was used. From this solution dilutions were made ranging from .01% to .00001%. This range of dilutions was satisfactory for determining the thresholds of the tasters.

The solutions used for testing the non-tasters were made from a stock solution of 1.0% containing 40% alcohol, which was found to be the best solvent in addition to water. Alcohol of a strength comparable to that used in the P. T. C. solutions was used to check all non-tasting subjects, so that they would not confuse the taste of the alcohol with the taste of P. T. C.

A beaker of distilled water was given to each subject before testing so that he might rinse his mouth and become acquainted with the taste of distilled water. He was also asked to rinse his mouth immediately after noting the taste of each solution given. The solutions were placed on the back of the tongue of the subject by means of long pipettes. The weakest solutions were given first to avoid over-stimulation of those who had low thresholds. A number of trials on solutions near the threshold of the subject were made and that concentration which gave a bitter taste in half of the trials made was considered the threshold. Some subjects, however, could always discriminate between one concentration and the next strongest one.

In considering the distribution of tasters and non-tasters among the white group and among the negroes, the frequencies are obviously disproportionate, and the two racial groups must therefore be considered separately. This conclusion is based on the X^2 (Chi square) value of 6.983. The corresponding probability lies beyond the .01 limits and must be taken as indicative of uncontrollable differences between the two racial groups.

The X^2 test as used here, and also in the statements following where male and female groups are compared, takes the form:

$$X^2 = \frac{\frac{\Sigma I}{\Sigma D}\left[\Sigma I\left(\Sigma \frac{D^2}{I}\right) - \left(\Sigma D\right)^2\right]}{\Sigma I - \Sigma D}$$

Here I equals the total in any sub-group and D equals the number of non-tasters in the sub-group. The degrees of freedom for checking the probability in tables of X^2 are always one less than the number of sub-samples.

The frequencies of tasters and non-tasters among the white males and females are proportionately homogenous by the above mentioned technique. There were 251 tasters and 61 non-tasters among the males, and 141 tasters and 24 non-tasters among the females. The probability for homogenity is approximately .20. Thus no division on the basis of sex can be made.

Table I gives the frequencies of tasters and non-tasters among the white and negro groups. In following the distribution through the table it will be noted that in general the frequencies give a bi-modal grouping of thresholds in regard to concentration. One mode appears among the tasters of crystals

TABLE I

FREQUENCIES OF TASTERS AND NON-TASTERS AMONG WHITE AND NEGRO GROUPS WITH THE SCALE OF DILUTIONS OF P. T. C. GIVEN IN FRACTIONS OF 1% SOLUTION

Fraction of 1% P. T. C. Solution	Number of White Individuals	Number of Negro Individuals	
Less than .00001	13	3	
.00001	18	7	
.00002	11	2	
.00003	3	1	
.00004	4	4	
.00005	7	2	
.00006	10	4	
.00007	4	3	
.00008	11	1	
.00009	25	3	
.0001	32	7	
.0002	55	9	
.0003	46	21	
.0004	36	10	Tasters of crystals
.0005	20	3	
.0006	14	2	
.0007	22	1	
.0008	9	3	
.0009	13	5	
.001	19	2	
.002	7	2	
.003	2	1	
.004	4	2	
.005	1	0	
.006	2	0	
.007	1	1	
.008	1	0	
.009	1	0	
.01	2	2	
.02	1	0	
.03	0	1	
.04	4	0	
.05	2	0	
.06	0	0	
.07	1	0	
.08	0	0	
.09	2	0	
.1	18	1	Non-taster of crystals
.2	20	0	
.3	14	2	
.4	3	0	
.5	4	0	
.6	1	0	
.7	0	0	
.8	0	0	
.9	2	0	
1.0	12	2	

and one modal group among the non-tasters. The continuous occurrance of individuals tasting the solutions throughout the series of dilutions would suggest that there are modifying

factors that are operating on the postulated simple pair of allelomorphs that determine the major segregation of the groups in either the tests with crystals or with the P. T. C. in solution. Another interesting feature is that some individuals in the one extreme of the tabulation could detect minute traces of the substance, less than .00001 of 1%. In the other extreme some individuals listed in the class of 1% could taste only heated solutions of which the true concentration was not determined.

It should be noted in the tabulation that the intervals of dilutions are not in unit steps. This, however, need not invalidate the description of the two general groups in terms of their means and standard errors. This frequency if plotted on an arithmetic scale would give the appearance of a heavily skewed sample, but the bi-modality would not be changed. The mean threshold of the 392 taster individuals among the white group falls at .00050 with a standard error of .000064, while the mean threshold of the 85 non-tasters falls at the .33341 level in the solutions with a standard error of .002425. The mean difference is .33291 with its standard error of .03315. The ratio of this difference to its standard error is then 10.04, and the two groups as differentiated bi-modally have an exceedingly small probability of having been drawn from a homogenous population with respect to thresholds of taste.

Among the negro group the 99 tasters of crystals show a mean threshold at the .00049 level of dilution. The mean threshold for the 8 non-tasters falls at the .3437 level of dilution. These means are proportionally equivalent to the means of the white group and can be taken as indicative of the true separation of tasters and non-tasters on the basis of threshold.

The results of the above tests show that testing by solution of different concentrations of P. T. C. distinguishes tasters from non-tasters as does testing with the crystals. The variation in thresholds show that extreme differences exist between individuals. This point is entirely lost when testing only with the crystals. Although the variation in threshold seems to indicate that modifying factors are effecting the reactions of taste, the data as a whole bear out the conclusion that lack of ability to taste crystals depends on a simple recessive factor. The quantitative treatment made possible by the threshold tests bring out the reactions of taste as a variable physiological phenomenon in line with genetic behavior.

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BOOK NOTICES

Insects and Spiders

From time to time during the past several years there appeared in the National Geographic Magazine articles concerning insects and spiders, accompanied by many colored illustrations of these forms. The National Geographic Society now brings together this collection of articles and colored illustrations into one volume. In examining the book, the most striking parts of it are the excellent color plates which are indeed works of art. The photographer, artist, and others who aided in the preparation of these illustrations are to be congratulated.

The book contains a foreword by Gilbert Grosvenor and the nine chapters have the following headings: I, Exploring the Wonders of the Insect World; II, Insect Rivals of the Rainbow; III, Man's Winged Ally, the Busy Honeybee; IV, Stalking Ants, Savage and Civilized; V, Living Casks of Honey; VI, Strange Habits of Familiar Moths and Butterflies; VII, Where Our Moths and Butterflies Roam; VIII, Afield with the Spiders; IX, California Trapdoor Spider Performs Engineering Marvels. The book is well indexed. Each of the above chapters is written by an outstanding worker in the particular subject discussed. The book is well written in a style to appeal to the layman. At times Dr. Showalter becomes teleological in some of his statements. Here is an example which appears on page 19: "But the caterpillar does not eat for today alone. It foresees a morrow when, undergoing its transformation, it will have to spend days on end without a single bite of food, etc."

The reviewer feels that a more appropriate title for the book could have been selected. The printing is on excellent quality paper and the volume is well bound. This book is recommended for lovers of nature and should be a valuable asset to biology teachers.—R. H. DAVIDSON.

Our Insect Friends and Foes and Spiders, by various authors. 252 pp., 242 figures, some colored. Washington, the National Geographic Society. $2.50.

The Orthopteran Genus Ceuthophilus

This admirable monograph sets a new standard for orthopterological publications. Although there probably remain many new species of Ceuthophilus to be described from North America, the publication will remain the standard work on the group for many years to come. The "camel crickets" or "stone crickets" have been the despair of entomologists, due partly to the lack of obvious characters for separation of the species and partly to the faulty foundation laid by early monographers. Until the appearance of the present work, few groups of insects have, in recent years, been in a more chaotic condition. Species had been described, unwittingly, from immature specimens, and the literature on the genus is cluttered with synonyms. The resultant taxonomic snarl was such that there are numerous inaccuracies in the determination of specimens by even the more expert of the students of the Orthoptera.

With genitalic characters as the basis, the author started in sixteen years ago to revise the group. Large series of specimens were amassed by his own personal efforts and an effort was made personally to examine every known specimen of Ceuthophilus in the collections of the country. As a result, 17,430 specimens are recorded in the study, in striking contrast with the 543 specimens upon which Scudder's revision was based. More than eighty North American species are treated, making the genus second only to Melanoplus among the Orthoptera, as regards number of species.

The author's treatment of the material is characterized, not only by great thoroughness and attention to detail, but also by keen taxonomic sense and good judgment. The work will be indispensable to any student who desires to recognize the species of this hitherto difficult genus. There are 26 plates with 843 figures, beautifully executed, showing outlines and structural details of the insects and 12 outline maps showing the known distribution of the species.—E. S. THOMAS.

A Monographic Revision of the Genus Ceuthophilus (Orthoptera, Gryllacrididae, Rhaphidophorinae), by Theodore Huntington Hubbell. 551 pp. University of Florida Publication, Biological Science Series, Vol. 2, No. 1, February, 1936. $3.75.

Interpretative Petrology

What is interpretative petrology? It is not optical mineralogy, descriptive petrography or a classification of rocks. It is rather an attempt to bring a chemical background, with the use of minals (component parts of minerals) to the aid of interpreting igneous rocks. In addition various theories as to the origin of igneous rocks are impartially presented with their good and bad parts pointed out. The text is divided into 27 chapters. The introduction shows the likeness of Silicon and Carbon. Chapter 2 details the principles of Equilibria, bringing into the picture the phase rule and the thermal diagram of both solid solutions and eutectic series. Solid solutions and isomorphism are discussed along with the term minal. Next we find discussed polymorphism, then readjustment during crystallization and petrologic mineralogy. Chapter 7 takes up the feldspar group, 8 the pyroxene group, 9 the olivine group, 10 the amphibole and mica groups, 11 the alkali minerals, 12 the accessory minerals, 13 zoned crystals, and 14 twinned crystals. In chapter 15 the order of crystallization is taken up and the criteria of the sequence of crystallization have their weak points pointed out. Intergrowths are considered along with crystallization. The discussion of hyperfusible constituents (the dissolved gases) is followed by a discussion of the minal types of the Pacific suite, Mediterranean type of rocks, and rock types of the Atlantic suite. The crystallization of magmas is followed by a discussion of differentiation of magmas. Assimilation is concerned with the heat supply, stoping and so on, and the conclusion is that "the **place** of such activity (assimilation) may be even more important than the **age.**" The final consolidation of igneous rocks includes a discussion of the pegmatites with a table of pegmatitic minerals divided into magmatic and replacing minerals. Garnet reaction rims are followed by the petrographic provinces and comagmatic regions. The origin of igneous rocks is discussed, beginning with the source of the magmas. Then are taken up the granitic rocks, the feldspathoidal rocks, the alnoitic rocks, the norites, the anorthosites and finally the gabbros. In all are given various theories but no personal conclusions. Mode versus Norm, grain size, and a resume as to future investigations close the text. There are both author and subject indices.

This book does not attempt to take up all the igneous rocks. The rock-making minerals are considered as solid solutions and there are many diagrams to illustrate the mineral systems. The text should prove very useful for the advanced student, since it represents the bringing together of a great amount of information in a very condensed form. It fills a field which as far as we know has not been entered in this manner before. The illustrations are numerous and very clear in spite of their small size, there often being over a dozen on the same plate.—Willard Berry.

Interpretative Petrology of the Igneous Rocks, by H. L. Alling. xv+354 pp. New York, the McGraw-Hill Book Co., 1936.

Human Heredity and Social Welfare

Dr. Holmes has broadened the scope of his eugenic studies which were reviewed some time ago in this journal (**The Eugenic Predicament**), and has presented in this volume a complete and well-written discussion of the whole field of human welfare as it is affected by the inheritance of genetic factors. The first half of the book consists of a clear account of the principles of heredity, culminating in a chapter on heredity in man. Then follow a series of thought-provoking chapters on genetics in crime, delinquency, and mental aberrations, the differential birth and death rates, the growth and distribution of populations, the biological effects of war, migrations, and the intermingling of races, and finally a chapter on proposed measures for race betterment. There is nothing startlingly new in the book, but it is written with the same calm, clear, dispassionate insight which characterizes all of Dr. Holmes' works, and is free from the somewhat forced rationalization which occurs in the recent works of Graubard and Muller. The reader may add much to his enjoyment and grasp of the volume by carefully answering the stimulating questions and problems which are appended to each chapter.—L. H. S.

Human Genetics and its Social Import, by S. J. Holmes. viii+414 pp. New York, the McGraw-Hill Book Co., 1936. $3.50.

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THE RÔLE OF FITNESS IN EVOLUTION

W. L. McATEE

Fitness, though so frequently referred to by selectionists, and a term of so much importance in their theory, nevertheless lacks definite meaning. Referring to ability to survive, its only proof under the theory is survival. This has been pointed out by various authors among whom we may quote Lloyd, "Fitness is not a reality in itself, it is only a term used to express the fact of survival." (8, 180.)

Those accustomed to look the least below the surface cannot accept this illogicality. They can, moreover, readily point out its falsity. Does not a forest fire, a flood, any sudden and overwhelming catastrophe, take lives without regard to individual qualifications? Many of the creatures destroyed must have been fit, in any reasonable sense of the word, but they did not survive.

The same thing is obvious in the case of mass eliminations by year classes among fishes, oysters, and coniferous seeds, for example. When all are eliminated the reason cannot be unfitness; and this is true also of the normal going under of a very high percentage of the individuals of any organism having large numbers of young. When 99% or more of the individuals are eliminated all cannot be unfit.

Fitness as the sole reason for survival and survival as the sole evidence of fitness are fruits of a type of philosophy that surely has run its course. If there is nothing of more real worth in the doctrine of the "survival of the fittest," the sooner it is abandoned, the better.

The selectionist idea of fitness being an impossible one, let us consider what is ordinarily meant by the term. Does it not merely mean apparent health as evidenced by good appearance, alertness, and vivacity? Is it not based on such qualifications as sound bodily condition, tissue tone, and good co-ordination?

Further, are not all these things largely of individual development?

INDIVIDUAL DEVELOPMENT OF FITNESS

The almost universal practice of athletics by those whose vocation does not involve sufficient bodily activity is acknowledgment by the human race that fitness must be individually acquired and maintained. The pitiful lack of development of children who have been closely confined is sad evidence on the negative side.

Breeders of animals know that if the young are not adequately fed and exercised and kept steadily progressing throughout the formative period they will never attain normal size and development.

The conditions of captivity profoundly affect animals and rearing in confinement prevents development of the fitness we observe in wild individuals of the same species. As to game birds an authority says:

"No birds that are kept in captivity and hand-fed are as sporty to shoot, or have the same flavor when eaten, as birds either raised in the wild state or put out at an early age to rustle for themselves. Birds liberated young soon become strong on the wing, and assimilate the craft of their forbears. The wild feed they subsist on, in addition to the planted grain, actually gives them a wild flavor when eaten. Thus, in a few weeks, they practically assume the status of wild birds. On the other hand, birds reared in captivity and placed in the coverts at maturity, and probably at the most not more than a week or two before they are shot, lack the above characteristics to a great extent, although the loss will be much less. They will probably be fatter, and therefore slower on the wing for this reason, as well as because of lack of exercise. In the case of pheasants, they are apt to run more, and not rise with the snap that characterizes the wild bird. Quail also act sluggish, and I have seen covies sneaking along through the grass, loath to rise until actually put up." (Smith, 10, 21–22.)

The differences in captive bred animals may extend even to deep-seated structural characters as those of the skeleton. For instance, Hollister shows that in captive lions "Changes in the skull which would be accepted as of 'specific' or possibly of 'generic' value in wild animals from different regions are thus produced in the life of a single individual." (7, 190.)

The following frequently quoted instance is of interest in this connection. "Some of our countrymen [Englishmen] engaged about the year 1825, in conducting one of the principal mining associations in Mexico, that of Real de Monte, carried out with them some English greyhounds of the best breed, to hunt the hares which abound in that country. * * * the scene of sport is at an elevation of about 9,000 feet above the level of the sea, and the mercury in the barometer stands habitually at the height of about 19 inches. It was found that the greyhounds could not support the fatigues of a long chase in this attenuated atmosphere, and before they could come up with their prey, they lay down gasping for breath; but these animals have produced whelps which have grown up, and are not in the least degree incommoded by want of density in the air, but run down the hares with as much ease as the fleetest of their race in this country." (Lyell, 9, 2, 297.)

We see in such cases the effect of environment and of the activities of the animal in the environment. We see that inheritance does not rule, that organisms will not develop their normal characteristics unless normally environed and exercised. We therefore conclude that fitness which above all things is of individual acquisition, is not inherited. Further testimony to this effect is given in the following section.

FITNESS NOT INHERITED

In sexually propagated organisms, all individual qualifications have to be developed from the egg anew. There is no direct transmission of them from adult to adult. As Hogben states the case for the human race, "Our parents do not endow us with characters. They endow us with genes." (6, 11.)

Further comment by authors along this line are quoted here.

"It is certain that in the past we have too readily assumed that characters which appear in successive generations are transmitted by heredity, and we have given too little attention to the possibility of their being acquired independently by each generation." (Conn, 3, 357.)

"Many characters of adult organisms consist in part of a genetic or hereditary contribution, which might be called a qualitative element, to which is added during growth a quantitative reaction to more or less favorable conditions, depending not only upon external circumstances but also upon the perfection and efficiency of the remainder of the organism." (Cook, 4, 255.)

"Individuals having the same hereditary composition may show very diverse characteristics in different environments." (Coe, 2, 111.)

"That many individuals of the species are distinctly ill adapted to their environment is a common observation, but this usually results from the failure of the individual to realize the full advantage of his heritage." (Coe, 2, 112.)

"An organism's qualities, characters, are the result of its development, as such they cannot be said to be inherited." (Hagedoorn, 5, 11.)

"It cannot be emphasized too strongly that the individual as we know him at any moment is the resultant of the hereditary qualities he possesses as developed by the particular environment in which he has lived." (Thompson, 11, 338.)

"Heredity does not account for the individual, but merely for the potentialities some of which are realized in the individual. In other words, the internal and transmitted factors are by themselves unable to 'produce' an animal at all. The same point of view has been developed by Goodrich, who stresses the distinction which has to be drawn between the process of transmission of the internal factors from parent to offspring, and the process of production in the offspring of characters similar to those which were possessed by the parent. 'An organism is moulded as the result of the interaction between the conditions or stimuli which make up its environment and the factors of inheritance. No single part is completely acquired, or due to inheritance alone. Characters are due to responses and have to be made anew at every generation.' Similar views have been expressed by Conklin." (de Beer, 1, 14–15.)

CONCLUSION

Instead of organisms living longest because they are fittest it is apparent that they may develop more and more fitness the longer they live (senile deterioration excepted). Fitness is distinctly a qualification that must be individually acquired, and is only fully developed by normal activity in a normal environment. It is not inherited nor can it be transmitted. Under this view it loses most of its importance for the theory of natural selection. The "survival of the fittest" is of no moment if fitness is not inherited.

Since the germinal constitution is probably not defective in the bulk of a population, it follows that almost any individuals of average fitness (capable of conjugation) would serve equally well as progenitors of the race. Since as a rule such ordinary individuals do in fact survive and reproduce their kind we must conclude that the role of the "fittest" in the organic world is not at all that attributed to it by the theory of "natural selection."

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Statistical Analysis

"Methods of Statistical Analysis," by C. H. Goulden, has been prepared on the assumption that a thorough knowledge of statistical methods, as applied to research problems, can be obtained best by actual practice in the application to field and laboratory experiments. It gives the theory and practice of statistical methods in a simple manner using a series of well graded examples for demonstration. It stresses throughout the logical development of the subject and the necessity for the use of exact methods. The text moves rapidly through the fundamentals, dealing with the "small sample technique and correlation in the early chapters. The main object of the book is to bring together a working knowledge of the concepts used in the analysis of variance. Over half the text is given to an elaboration of this technique. Each chapter has a series of carefully selected exercises with the raw data from which they can be worked.

The appendix gives G. W. Snedecor's table of "F and t," which is an excellent aid in directly checking significant probabilities in either simple problems or in any elaboration following analysis of variance.—R. G. SCHOTT.

Methods of Statistical Analysis, by C. H. Goulden. 165 pp. Minneapolis, The Burgess Publishing Co., 1936. $3.00.

THE POSTULATED RESEMBLANCE OF NATURAL TO ARTIFICIAL SELECTION

W. L. McATEE

"*A parallelism that does not exist.*"—HERBERT SPENCER (18, 440).

INTRODUCTION

Much of Darwin's book, "The Origin of Species by Means of Natural Selection" and most of his larger work, "The Variation of Animals and Plants under Domestication," is devoted to exposition of his postulate that "natural selection" is a process comparable to that exercised by man on domesticated animals and plants. A few quotations will illustrate the point.

"The term [natural selection] is so far a good one as it brings into connection the production of domestic races by man's power of selection and the natural preservation of varieties and species in a state of nature." (7, 1, 6.)

"The principle of natural selection may be looked at as a mere hypothesis but rendered to some degree probable by what we positively know of the struggle for existence, and the consequent almost inevitable preservation of favourable variations, and from the analogical formation of domestic races." (7, 1, 9.)

"As man can produce, and certainly has produced, a great result by his * * * selection, what may not natural selection effect?" (6, 72.)

In any discussion much depends on what is meant by the basic terms involved. Let Darwin's own definitions, therefore, prevail. As to natural selection, he says, "Can we doubt * * * that individuals having any advantage, however slight, over others, would have the best chance of surviving and procreating their kind? On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. The preservation of favorable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection, or the Survival of the Fittest." (6, 70.)

As to artificial selection, he says, "We cannot suppose that all the breeds were suddenly produced as perfect and as useful as

we now see them; indeed in many cases we know that this has not been their history. The key is man's power of accumulative selection; nature gives successive variations; man adds them up in certain directions useful to him. In this sense he may be said to have made for himself useful breeds." (6, 25.)

Some rather fundamental differences between artificial selection and the biological events dubbed "natural selection" are obvious on first consideration. For instance, in the artificial process there is always, in the natural, never, a conscious selector; in the former, selection is for the benefit of the selector, in the latter it is supposed to benefit the selected; man makes conditions as favorable as possible for the organisms under his selection; Nature, Darwinians inform us, always puts hers through a merciless struggle for existence. These and other contrasts between artificial and natural selection will be more fully discussed under separate headings.

SELECTORS

In artificial selection there is always conscious human choice directed toward definite ends, toward something more than mere maintenance of the existence of races. In nature there is elimination, there is death, but no selector, nor anything comparable to one; consequently there are no definite ends, no objects in view, beyond keeping "seed alive upon the face of the earth." On the other hand, human effort may be directed for generations to the same end as, for instance, increase of speed in horses, milk yield in dairy cattle, or egg production in fowls. In nature the so-called selection by elimination may at one time be the result of climatic severity, at another of disease, again of depredations by enemies, and so on; the number of eliminating agents may be almost infinite. There can be no continuity of development along particular lines as the result of elimination for an infinity of reasons. The fact that steady evolutionary progress is known only goes to show that factors other than those causing elimination are in control.

Writing of artificial selection, Darwin says, "As each new variety is produced, the earlier, intermediate, and less valuable forms will be neglected and perish." (7, II, 231.) By contrast it must be pointed out that in nature where there are no conscious selectors, there will be no judgment as to less valuable forms, and no power to neglect.

FOR WHOSE GOOD?

Darwin admits the contrast between artificial and natural selection as to beneficiaries. "It is not surprising," he states, "that domestic races should generally present a different aspect from natural species. Man selects and propagates modifications solely for his own use or fancy and not for the creature's own good." (7, II, 232.)

In the "Origin of Species" he further says, "Man selects only for his own good; nature only for that of the being which she tends." (6, 72.) No comment would seem to be necessary in certifying as to this distinction between artificial and natural selection.

FITNESS

Artificial selection need scarcely be concerned with the utility of a character to the organism, or even indeed of the general fitness of the latter, while in natural selection, according to theory, utility of characters and general fitness are the ruling factors. This point also is conceded by Darwin, who says:

"It is obvious that a host of artificial races could never survive in a state of nature;—such as Italian greyhounds,—hairless and almost toothless Turkish dogs,—fantail pigeons, which cannot fly well against a strong wind,—barbs and Polish fowls, with their vision impeded by their eye wattles and great topknots,—hornless bulls and rams, which consequently cannot cope with other males, and thus have a poor chance of leaving offspring,—seedless plants, and many other such cases," (7, II, 212), and adds, "Our wonderfully improved pigs could never have been formed if they had been forced to search for their own food." (7, II, 220.) He further states: "With animals and plants reared by man there is no severe or recurrent struggle for existence." (7, II, 309.) Like most voluminous writers, however, Darwin makes some more or less contradictory remarks, one bearing on the present topic being, "With our domesticated animals natural selection checks the production of races with any injurious deviation of structure." (7, II, 420.) In view of swine that can hardly waddle; ducks, geese, and chickens that cannot fly; dogs, chickens, pigeons with impeded vision, etc., this remark can scarcely be taken seriously. The keeping of many such domesticated animals in defensive enclosures, and canaries and other cage-bred birds constantly in cages is eloquent admission that they do have

injurious deviations of structure and are unfit for life in the open. Evidently they have not been selected for fitness.

In artificial selection a considerable fault may be overlooked if a very desirable virtue is present. In natural selection (as defined) elimination for the fault would proceed, no account being taken of the virtue. Artificial selection as a rule degrades organisms in point of fitness so far as ability to survive in the wild is concerned. Natural selection if it acts as claimed must do the very opposite. It is difficult to trace any similarity of the two processes in relation to fitness.

STRUGGLE FOR EXISTENCE

The conception of a severe struggle for existence is in reality antithetical, rather than contributory, to the ideal of the survival of the fittest. J. W. Dawson pointed this out clearly when reviewing Darwin's "Origin of Species" in 1860. "We have been told very truly," he says, "that the reason the wealthy and skillful breeder succeeds in producing marked races is that his animals are cared for and pampered, while the savage and the poor man fail because their animals must struggle for subsistence. Nature it appears takes the opposite way, and improves her breeds by putting them through a course of toil and starvation, a struggle not for happiness or subsistence, but for bare existence. We can understand how this should deteriorate and degrade species, as we know it has done in every case of the kind we have observed; but how it should elevate or improve is past comprehension. But does Nature deserve to be charged with such niggardliness, and with so concealing it that all the world seems to be full of happiness and plenty, except where poor man toils on in his poverty?" (81, 112.)

Man's selection is of individuals to live and be given the most favorable treatment practicable, while nature's is of those doomed to die, the survivors according to theory being those that have passed through a struggle for existence so severe as to kill off all but a small proportion of the total number of offspring. Man pampers, and improves his selections; Nature's process as pictured by the Darwinian theory could only leave broken and enfeebled remnants in no wise entitled to be called the fittest. The fact that most creatures under natural conditions are sound and in good condition is proof that they have not been subjected to a ruthless struggle for existence. The

death of some, the escape of others apparently unscathed, very clearly shows the workings of a process akin to chance rather than one of selection.

ELIMINATION OF YOUNG

Wholesale destruction of immature stages is the rule in nature. "Selection," if it can be so termed, occurs chiefly before the adult characters, those upon which continuance of the race depends, are developed. Except in highly polygamous species a large proportion of those attaining maturity participate more or less in the reproduction of the species. The plant or animal breeder, on the other hand, must rear his material until adult characters are apparent, and in his most effective operations, until ability to transmit desirable qualities is tested. The process is quite distinct from what does or can occur in nature.

PROGENY PERFORMANCE

The term "prepotency," old in breeder's language, signifies marked power to transmit likeness. Darwin remarked, "The subject of prepotency is extremely intricate * * * no one has hitherto succeeded in drawing up general rules on the subject." (7, II, 47.) In their attempts to utilize prepotency pioneer breeders were groping for a tool which later has been firmly grasped and recognized as the most effective at the breeder's command. It is the progeny test.

"The term progeny test as applied to animal breeding, refers to the estimation of an individual's value as a breeder by means of the qualities or performance of its offspring. The earlier practice was to judge an individual by its ancestors as indicated by its pedigree, but more recently the situation has been reversed and now the individual breeding bird [fowl] is judged by its offspring." (Warren, 20, 3–4.)

"The foregoing discussion indicates that the only dependable measure of a bird's breeding value is the progeny test. If this be true, the question then arises as to what value the pedigree has. In reality the pedigree does not have the value placed upon it by many animal breeders. It supplies some history of the performance of a bird's ancestry, but gives no assurance that the same qualities will be transmitted by this bird to its offspring." (Warren, 20, 19.)

"The mean egg production of the daughters of the mating

of a given sire and a given dam is the index of greatest value in determining the breeding potentiality of an individual sire or dam." (Jull, 14, 513.)

"The idea of rating bulls by the progeny test is not new. Such historic livestock improvers as Bakewell and Cruickshank are known to have hired out bulls to their neighbours, bringing them back into their own herds again if they proved themselves by their progeny. The underlying principles of the progeny test are sound genetically. It is the aim of the scientific breeder to assess the transmitting abilities of his stock and, as has been mentioned, this is scarcely ever possible to a sufficient degree in the case of the female, although more often available in the case of the male with his large number of offspring. With ten daughters to a bull out of ten different dams, there are ten indications of the transmitting abilities of the bull, against only one of each individual dam. In the process of proving a bull it is obviously of primary importance that all his daughters be considered—that there be no selection. Systems which allow of the practice of testing only the best daughters or of considering a bull proved when he has a fixed number of daughters exceeding an arbitrary level of production are very inadequate. Information on the numbers and performances of low producers is as valuable as it is on the high producers." (Edwards, 9, 820.)

"Selection has as its objective the identification and propagation of those superior individuals which are believed to be capable of reproducing their good qualities in their offspring. Here the progeny test becomes extremely valuable, for by its aid—and I think no one will question its indispensability—it is possible to obtain a reading of each breeder's worth and thus recognize those individuals that should be continued in active service as well as the best manner of mating them in the future." (Goodale, 11, 486.)

"Improvement is next to—if not actually—impossible when bulls are selected for breeding at random, which is what selection without a progeny test amounts to." (Goodale, 11, 496.)

"Practically everywhere, the plant-breeders have abandoned their selection according to individual merit * * * and resorted to some system of judging plants after their progeny." (Hagedoorn, 13, 191.)

"Repeated attempts by plant breeders, working with different species of both self-fertilized and cross-fertilized crops,

have failed to discover any sound basis for selection of parent plants except that which involves a progeny test." (Kirk, 15, 515.)

"Any of the progeny tests are better than selection on type and pedigree only." (Warwick & Copeland, 21, 181.)

From these positive statements of a number of modern authorities, it seems unquestioned that the progeny test is the most effective basis for selection available to either plant or animal breeders. It is obvious without discussion that the method can have no part in "natural selection."

PEDIGREE BREEDING

While the progeny test looks towards the qualities of offspring, pedigree breeding pays most attention to those of ancestors. This method, while still used, was of greater importance in times prior to widespread recognition of the value of the progeny test. It was, however, and still is an important part of artificial selection but of course cannot occur in nature.

COMMENT IN BRIEF, MOSTLY FROM OTHER AUTHORS

The usual fertility of domestic races when crossed is in strong contrast to the usual mutual infertility of natural species.

Races created by artificial selection, left to themselves, tend to revert to the original type. Natural species tend to continue as they are.

In artificial selection the old form may be preserved alongside the new. In natural selection the new is supposed to supplant the old.

The changes in natural evolution seem to be characteristically slow while very striking changes have been produced in a few years by artificial selection.

"Natural selection is not a force like that of the breeder who looks over his animals and selects some few that have a given character especially developed. The word 'selection' is here misleading. There is in nature no selector and no selecting. Nature does not select the best, but simply eliminates the worst. There is a great difference between a process that consciously picks out the best and one that unconsciously eliminates the worst." (Conn, 3, 70.)

"Under unconscious or natural selection only the most deficient of these characters are rejected; under conscious or

artificial selection by man only the most proficient are saved." (Cook, 4, 279.)

"Domestication * * * shows us only the conditions in which constructive evolution does not take place, even in nature." (Cook, 4, 361.)

"While artificial selection involves intelligent choice in the destruction of superfluous individuals, natural selection, * * * is non-selective. It involves destruction but not construction." (Cuénot fide Gerould, 10, 121.)

Artificial selection proceeds under environmental conditions that are made uniform as possible; "the external environment when natural selection occurs is exceedingly complex." (Bucholz, 1, 278.)

"Artificial selection sets a uniform standard of excellence of performance for all participants," (Bucholz, 1, 279); in "natural selection" this is rendered impossible by the great diversity of environment.

While it will not be admitted by staunch selectionists, elimination in nature (or "natural selection") is very indiscriminate. "In fact so complex is the environment * * * that accident and chance really play a major role." (Bucholz, 1, 279.) In artificial selection, on the contrary, individuals in the least undesirable may be rigidly eliminated.

"Where, as in nature, the variable offspring of an occasional cross goes under into the multitude, under cultivation aberrant individuals are apt to be noticed and given a chance to show their value. Under cultivation both processes in evolution, on one hand heightening of variability by crossing, and on the other hand reduction of variability by isolation, selection and colonization are exaggerated far beyond anything we can ever hope to find in nature. Propagation of plants and animals under domestication is essentially different from propagation in nature, as the former is essentially a continued system of colonization." (Hagedoorn, 13, 231.)

"Man introduces animals into new conditions, teaches them new habits, or develops old habits, and the inevitable consequence is, that a considerable change takes place which transmutes species quite apart from any selective influences." (Coe, 2, 132.)

"Natural Selection, which is supposed to dominate nature and largely to direct the transmutation of species, must act, if it acts at all, under disabilities which would make all the

efforts of Artificial Selection futile, and yet the experiment of Artificial Selection is cited as the most convincing proof of the reality of * * * (Natural) Selection. * * * No practical man would think of adopting the method which is supposed to take place in nature, because he knows that it would be a complete failure." (Coe, 2, 155, 156.)

"The essential factors which have been involved in the production of our best fruits, grains, vegetables, flowers, etc., have been (1) the improved conditions of domestication, (2) mutations, leading at once to new and better forms, (3) hybridization, which by new combinations of characters and as a result of heterosis has led to amelioration, and (4) the purification of previously mixed races or varieties by selective sorting. It is to the overwhelming importance of one or a combination of these factors that the 'experience of breeders' points and not to Darwinian selection." (Pearl, 17, 81.)

SUMMARY

There are enumerated in previous pages some fifteen to twenty differences between the processes of artificial and "natural" selection, and these are not all that have been pointed out in the literature. In several respects the two processes are diametrically opposite in character. Some of the most effective factors in artificial selection as pampering, conscious choice, and preservation on the ground of ancestral pedigree or progeny performance cannot possibly be a part of "natural selection."

On the other hand, the intensity of elimination of the immature, the rigid destruction of variations "in the least degree injurious," the severity of the struggle for existence, reducing every generation, whatever its increase, back to its original numbers, features which by hypothesis, or in fact characterize "natural selection," are quite different from the processes of artificial selection.

Darwin tried to show how "natural selection" is similar to the art of breeders, but if he had ever contemplated the matter in reverse he would have realized that the methods he attributes to Nature are not imitated by man, and that if they were the achievements of artificial selection would have been quite impossible.

To those fond of equations it may seem elementary to say that if a = b, then b = a. Even so elementary a test, however, has not been applied by selectionists to the dogma discussed

in this paper. If "natural selection" is similar or analogous ("precisely analogous" according to Romanes) to artificial selection, then artificial selection should be similar or analogous to "natural selection."

For variety's sake let us turn to the Encyclopaedia Brittanica for definitions. There we learn that in artificial selection "the choice of the individual for further breeding is determined by (1) its appearance, (2) the record of its ancestry (pedigree) and (3) the record of its progeny (the progeny test)." (Crew, 5, 296.) All of these criteria can operate only through conscious choice and the second and third of them must have the aid of records. Surely only a hardy spirit can believe that anything at all comparable exists in nature.

As to "natural selection," we read, "according to Darwin, then, the chief factors which contribute to the process of evolution are variation, heredity, and the struggle for existence. To their combined action he gave the name 'natural selection' in analogy with the similar process carried out by man on domestic plants and animals." (Goodrich, 12, 920.) Since variation and heredity must be considered as of more or less the same value whether in the artificial or the natural process, it is apparent that everything depends on the meaning of "the struggle for existence"—Nature's "selecting" device. Extracting briefly from the definition of this struggle it appears that, "There is a perpetual competition for space, food, and all necessaries of life. * * * If one [species] increases it must be at the expense of some other. * * * on the average only two individuals can survive to replace the parents out of the whole number of offspring. As a rule the greatest destruction takes place when the organisms are quite young. * * * Just as the intensity of the struggle may be measured by the death rate, so a variation is advantageous in so far as it lowers this rate; and this gives a measure of its 'selection value'." (Goodrich, 12, 923.)

We see nothing here of special care, or of conscious choice, of pedigree breeding, or of progeny testing, the whole of artificial selection; we see instead a formidable array of destructive processes all of which so far as possible are excluded from artificial selection.

If belief in "natural selection" depends on its analogy to artificial selection then that belief can scarcely prevail.

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PANGONIINAE OF UTAH (TABANIDAE: DIPTERA[1])

J. A. ROWE AND G. F. KNOWLTON[2]

The abundance, the blood-sucking habits, the annoyance to livestock and man, and the actual and potential ability to transmit disease makes the family Tabanidae of particular importance in Utah. Studies of insect transmission of equine encephalomyelitis, conducted at the Utah Agricultural Experiment Station, and the need for more ready recognition of the species in the field, has led to the present treatment.

The writers are indebted: To Dr. V. M. Tanner, Brigham Young University, Provo, Utah, for so generously lending material; and to Dr. C. B. Philip, of the U. S. Public Health Service, and Dr. A. Stone, of the U. S. Bureau of Entomology and Plant Quarantine, for helpful suggestions and identifications.

The Pangoniinae are horseflies which bear apical spurs on the hind tibiae.

KEY TO GENERA

1. Eyes distinctly pubescent .... **Osca** Walker
   Eyes bare 2
2. Third segment of antennae with at least seven annuli, front of female much wider below than above .... **Apatolestes** Williston
   Third segment of antennae with not more than five annuli, front of female almost parallel-sided 3
3. Second segment of antennae only half as long as the first, eyes in life with many small dots .... **Silvius** Meigen
   Second segment of antennae as long or nearly as long as the first, wings with dark pictures .... **Chrysops** Meigen

Osca californica (Big.)

Diatomineura californica Bigot, Mem. Soc. Zool. France, 5: 618. 1892.
Pangonia dives Will., Kan. Acad. Sci., 10: 130. 1886.

Characteristics—Large and robust; general color yellow; each abdominal tergite with anterior half brown or black and posterior half yellow; male more pilose than female, with the black of the abdomen often in the form of a median row of spots; antennae reddish-yellow, annulate portion black.

Habitat—Logan, Brigham, Farmington, Salt Lake City.

Hine (1904) declared the synonomy of *D. californica* Big. (1892), with *P. dives* Will. 1887; however, there is an earlier *P. dives* Macquart (1857), and by reason of this preoccupation Bigot's name should stand.

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[1]Contribution from the Department of Entomology, Utah Agricultural Experiment Station.

[2]Co-authors: Graduate Research Assistant and Associate Entomologist, respectively. Publication authorized by Director.

This species has been referred to various genera including *Buplex* Aust., *Scaptia* Walk., and *Osca* Walk. Because of the pubescence of the eyes it should not be referred to *Buplex*. Major Austen of the British Museum has compared it with *Pangonia patula* Walk. and *P. crassa* Walk., both of which were referred to *Scaptia* by Walker; it is Austen's opinion that this species is not referable to *Scaptia* but to *Osca*. Following Hine (1920, 1925), this species would be referred to as *Osca* Walk.

Apatolestes comastes Will.

Williston, Entom. Americana, 1: 12. 1885

This genus and species is not represented in our collection, but the close proximity of its range to Utah warrants mention here. The front of the female is much wider below than above and nearly entirely shining black.

Habitat—California, Arizona.

Genus **Silvius** Meigen

Meigen, Syst. Beschr. Zweifl. Ins., 2: 27. 1820

Hind tibiae with spurs at tip; first posterior cell open; ocelli present, wings usually with isolated spots and a rather large stigmal spot; eyes bare or with few short, scattered hairs; third segment of antennae composed of five annuli, the first much longer than those following, second segment of antennae half as long as first; type, *Tabanus vituli* Fabr.

KEY TO SPECIES

1. Wing with no black spots, body yellowish........................**gigantulus**
   Wing with black spots, body silvery.................................... 2
2. Dorsum of thorax with blackish stripes, abdomen with four distinct rows of black spots..**quadrivittatus**
   Dorsum of thorax without blackish stripes, abdomen with two rows of black spots or none..**pollinosus**

Silvius quadrivittatus (Say)

Say, Jour. Acad. Sci., Phil., 3: 33. 1923. (*Chrysops*), near Rocky Mountains

Characteristics—The key will serve to separate this species.

Habitat—Ft. Duchesne, Salina, Bluff, Zion National Park, and Santa Clara.

Silvius gigantulus (Loew)

Loew, Cent., 10: 12 (*Chrysops*), California

This species is not represented in our collection, but its extensive western distribution indicates that it probably occurs within the state. The wings are hyaline and without spots and yellowish along the costa; body yellowish; antennae yellowish, with the greater part of third segment brown; face with two small spots in triangular frontal callosity and ocelli dark brown; remainder of head and thorax yellow pollinose, with yellow pile.

Habitat—Vancouver Island, Washington, Colorado, California, Idaho, and New Mexico.

Silvius pollinosus Will.

Williston, Conn. Acad. Sci., 4: 244. 1880
Williston, Kans. Acad. Sci., 10: 131 (Western Kansas), 1886

Published records for Utah (Knowlton, 1931, 1934), from Ft. Duchesne (June 2, 1926) (W. Sorenson) may have been given from a misidentified *S. quadvivittatus.* This species is not represented in our collection and it is doubtful if it occurs in the state. It differs from *S. quadrivittatus* in having the wings more whitish; dorsum of abdomen with two rows of black spots or none; no black stripes on the dorsum of the thorax.

Genus **Chrysops** Meigen

Meigen, Illiger's Mag., 2: 267. 1803
Meigen, Syst. Beschr., 2: 50. 1820

Characteristics—Eyes bare or with few short, scattered hairs, with irregular green patches in life; ocelli present; wings with dark connected pictures, first posterior cell open; hind tibiae with spurs at the tip (sometimes small); third antennal composed of five annuli, the first much longer than the succeeding ones; second antennal more than half as long, or equal to, the third; type, *Tabanus caecutiens* Linn.

KEY TO SPECIES

1. Apex of the wing beyond the cross-band entirely hyaline or with the marginal cell slightly dusky.......... 2
   Apex of the wing beyond the cross-band not entirely hyaline, usually with a prominent apical dark cloud extending at least into the submarginal cell.......... 4
2. Abdomen with greater part of first two segments yellow (Fig. 2)....**excitans**
   Abdomen with first two segments black.......... 3
3. Base of fifth posterior cell hyaline, anal and axillary cells entirely hyaline (Fig. 5)..........**carbonarius**
   Base of fifth posterior cell dark, anal and axillary cells smoky along the sixth long vein (Fig. 11)..........**mitis**
4. First antennal segment distinctly dilated.......... 5
   First antennal segment not dilated.......... 7
5. Hyaline triangle of wing separated from the posterior margin of the wing (Fig. 13)..........**fulvaster**
   Hyaline triangle reaching posterior margin of wing.......... 6
6. Wing with hyaline spots in the first submarginal, discal and fourth posterior cells (Fig. 8). Callosities of head and first antennal segment extremely dilated (Fig. 14)..........**dilatus** n. sp.
   Wing with the above cells entirely infuscated (Fig. 9). Callosities of the head and first antennal segment moderately dilated........**coquillettii**
7. Wings with a hyaline spot in the discal cell (Fig. 10). Abdomen yellowish with four rows of black spots..........**discalis**
   Wings with discal cell infuscated.......... 8
8. Abdomen entirely black, apical spot of the wing separated from the cross-band (Fig. 12)..........**noctifer**
   Abdomen bicolored, apical spot of wing connected to cross-band.......... 9
9. Second segment of abdomen with a black spot on the sides (Fig. 4). Wings with the apical spot narrow, confined to the costal border (Fig. 7)..........**aestuans**
   Second abdominal segment yellow on the sides (Fig. 3). Apical spot not confined to costal margin..........**lupus**

Chrysops aestuans v. d. Wulp

C. moerens Walker, List., 1: 201. 1848.
C. aestuans v. d. W. Tijdsch. Vor Ent., 10: 135. 1867.

Characteristics—Abdomen black beyond second tergite, with a median row of prominent gray triangles; second tergite with two lateral black triangles (these often not entirely isolated in the male); wings with the apical spot confined to the costal margin.

Habitat—Logan, Locomotive Springs, Penrose, Corinne, Utah; Paris, Idaho. This species is quite common, often taken with *C. fulvaster* but less abundant. The synonomy is by C. B. Philip, 1931.

Chrysops carbonarius Walker

Walker, List, I: 203. London. 1848
Hine, Ohio Nat., 5: 220. 1904
Philip, Minn. Agr. Exp. Sta. Tech Bul. 80: 84. 1931

Characteristics—Abdomen uniformly black; wings beyond cross-band hyaline; base of fifth posterior cell hyaline.

Hine (1904) has given the synonyms of this species as worked out by Osten Sacken and Miss Ricardo as *C. niger* Walk. (not Macq.), *C. provocans* Walk., *C. atru* Macq., *C. fugaz* O. S. The Aldrich catalog (1905) lists *C. carbonarius* Walk. as variety B. of *C. niger* Macq.; *Chrysops niger* Macq. has not been taken from this state, but we have a specimen from Ohio which differs greatly from our *C. carbonarius* Walk. The writers are of the opinion that both should be considered as valid species. *C. carbonarius* can be distinguished from *C. mitis* by the hyaline base of the fifth posterior cell and by the hyaline character of the anal cell and axillary lobe.

Habitat—Plain City, Sheep Creek (Duchesne Co.).

Chrysops coquillettii Hine

Hine, Ohio Nat., 5: 220. 1904

Characteristics—First segment of antennae dilated; second tergite yellow with a median, geminate black spot; wings of female as shown in Figure 9.

Habitat—Zion National Park and Glendale.

Chrysops dilatus n. sp.

Female—Length, 7 mm.; occiput yellowish-gray pollinose; ocellar area polished black, quite small; frontal callus very prominent, somewhat tri-lobed when viewed from behind, polished yellow with a black spot on either side, otherwise vertex and front yellow pollinose; facial callositus exceedingly prominent polished yellow, except for a narrow yellow pollinose strip below the antennae; genae yellow except for a minute black spot below, polished only below the black spot, otherwise yellow pollinose; antennae very long, first segment unusually dilated (Fig. 14), yellowish; second segment somewhat dilated over the basal two-thirds, shorter than the third, yellowish; third black, first annuli somewhat lighter; thorax black in ground color; notum yellowish gray pollinose, thicker along two indistinct narrow lateral stripes; pleura

uniformly yellowish-gray pollinose; legs, including fore coxae, yellow except the joints, the apical third of the first tibiae, and the greater part of all tarsi which are black; wings (Fig. 8) peculiar in having the first submarginal discal and fourth posterior cells with prominent hyaline spots; abdomen dark in ground color, lighter on the caudal margin of segments; notum grayish-yellow pollinose and with two rows of sub-polished dark spots.

One specimen has the abdomen yellow in ground color, which makes the spots of the dorsum more conspicuous. The hyaline spots in the dark cross-band are distinctive.

Holotype—Leeds, Utah, July 10, 1934 (Knowlton and Smith). In collection of the U. S. National Museum. *Paratypes*—One female, St. George, (Tanner); 20 specimens, Leeds, June 16, 1935 (Knowlton and C. J. Sorenson); Zion National Park, August 13, 1929; Pinturia, August 11, 1929; St. George, June 5–7, 1919, in Utah. Paratypes in the collections of the Entomology Departments of: Ohio State University, University of Kansas, Brigham Young University, Utah Agricultural Experiment Station, and of Dr. C. B. Philip.

Dr. C. B. Philip compared the material of *Chrysops dilatus* n. sp. with material of *C. pachycera* Will. in the University of Kansas collection. Dr. Philip reported that the Utah material would, in his opinion, constitute at least a good variety, although some workers might not consider that it should rank as a distinct species. The wing pattern is usually constant throughout the large series of Utah specimens examined.

Chrysops discalis Williston

Williston, Trans. Conn. Acad. Sci., 4: 245. 1880
Hine, Ohio Nat., 5: 221. 1904

Characteristics—General color gray; abdomen grayish with four rows of black spots; wings with discal cell hyaline.

Habitat—Many localities throughout northern and central Utah. This species is one of the most common and is particularly fond of open salt marshes.

Chrysops excitans Walker

Walker, Dept. Ins. Sound: 72. London. 1850
Osten Sacken, Prodome, 2: 373. 1875
Hine, Ohio Nat., 5: 222. 1904
Philip, Minn. Agr. Exp. Sta. Tech. Bul. 80: 84. 1931

Characteristics—Wings beyond cross-band hyaline; first two tergites yellow with a median black spot on each, that of the second deeply posteriorly emarginate; remainder of abdomen black.

Philip, 1931, declares *C. sordidus* Washb. (1905) a synonym.

Habitat—Uintah Mountains.

Chrysops fulvaster O. S.

O. S. Bull. U. S. Geol. Surv. of the Terr., 3: 221. 1887
Hine, Ohio Nat., 5: 223. 1904

Characteristics—The first antennal segment dilated; wings with the hyaline triangle separated from the posterior border of the wing; a brownish species.

Philip (1931) gives *Heterochrysops fulvaster* Krober (1928) as a synonym.

Habitat—This is the most common species of the genus in Utah and has been taken in numerous localities throughout the state. The females are vicious biters and readily attack man. It is a constant pest of domestic animals, especially those corralled near saltmarsh areas.

Chrysops lupus Whitney

Whitney, Canadian Entomologist, 36: 205. 1904
Hine, Ohio Nat., 5: 224. 1904
Philip, Minn. Agr. Exp. Sta. Tech. Bul. 80: 88. 1931

Characteristics—Wings with prominent apical spot, hyaline triangle extending across second long vein; abdomen predominately yellow; first and second tergite yellow, each with a median black spot, that of the second emarginate behind; third and fourth tergites each with four black spots, the lateral ones less prominent.

Habitat—Provo.

Some workers consider this species a synonym of *C. furcatus* Walk., but *C. lupus* has the lower half of the genae black while those of *C. furcatus* are entirely yellow. The distribution of the two seem to suggest that they are distinct species.

Chrysops mitis O. S.

O. S. Mem. Bost. Soc. Nat. Hist., 2: 374 (Prodome). 1875
Hine, Ohio Nat., 5: 224. 1904
Philip, Minn. Agr. Exp. Sta. Tech. Bul. 80: 89. 1931

Characteristics—This species can be separated from *C. carbonarius* by its somewhat larger size, the infuscation of the base of the fifth posterior cell, the infuscation along the sixth long vein, and the subhyaline appearance of the axillary lobe.

Habitat—Snowville.

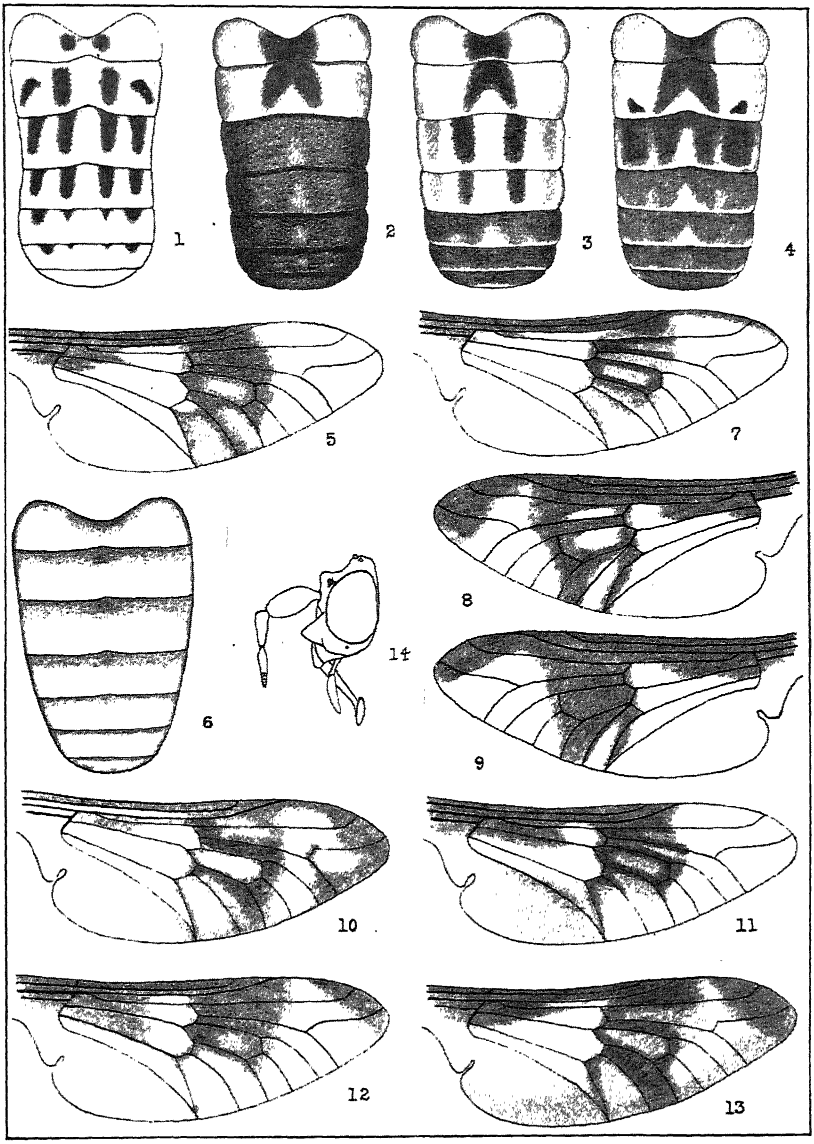
Chrysops noctifer O. S.

O. S. Bull. U. S. Geol. Surv. of the Terr., 3: 220. 1877
C. pertinax Will., Tran. Kan. Acad. Sci., 10: 132. 1886
C. nigriventris Big., Mem. Soc. Zool. Fr. 5: 604. 1892

Characteristics—Color black; tergites with white pile quite distinctly arranged on the lateral margins, a rather large lateral thinly pollinose spot on the first and second tergite, a distinct median row of spots which seem to fade out on the apical tergites; wings with the apical spot separated from the cross-band.

Habitat—Dry Canyon (Logan), Mirror Lake (Uintah Mts.), Aspen Grove (Timpanogos). This species seems to be more or less restricted to the mountainous areas of the state.

The synonomy is by Hine (1904).



Illustrations of Utah Pangoniinae

1. *S. quadrivittatus* (Say).
2. *C. excitans* Walker
3. *C. lupus* Whitney.
4. *C. aestuans* v. d. Wulp.
5. *C. carbonarius* Walker.
6. *O. californica* (Big.)
7. *C. aestuans* v. d. Wulp.
8. *C. dilatus* n. sp.
9. *C. coquillettii* Hine.
10. *C. discalis* Williston.
11. *C. mitis* O. S.
12. *C. noctifer* O. S.
13. *C. fulvaster* O. S.
14. *C. dilatus* n. sp.

SEVERAL NEW SILURIAN CEPHALOPODS AND CRINOIDS, CHIEFLY FROM OHIO AND HUDSON BAY

THE LATE AUG. F. FOERSTE

A. CEPHALOPODS

In 1927 a paper on the Ordovician and Silurian Cephalopods of the Hudson Bay Area was published by Aug. F. Foerste and T. E. Savage, in volume 22 of the Denison University Bulletin, Journal of the Scientific Laboratories. Since that time several specimens, collected by Professors Savage and Van Tuyl, have turned up and are described here.

Among these are two specimens from the Port Nelson limestone, described here under *Osbornoceras savagei*. These are of interest chiefly on account of their apparent similarity exteriorly to the genotype of *Osbornoceras*, namely, *Osbornoceras swinnertoni*, recently found in the Brassfield limestone in southwestern Ohio.

The Port Nelson limestone includes all of those Silurian strata in the Hudson Bay area which are below the top of the layers containing *Virginia decussata*. A few feet above this *Virgiana decussata* horizon there is a zone containing *Camarotoechia* (?) *winiskensis* Whiteaves, *Pterinea occidentalis* Whiteaves, *Isochilina latimarginata* Jones, and *Leperditia hisingeri fabulina* Jones. This horizon is included in the Severn River limestone. Both horizons occur at the Grand Rapids of the Saskatchewan river, near the northwestern margin of Lake Winnipeg. The fossils characteristic of the Severn River limestone occur also in the Wabi formation of the Lake Timiskaming area. In the northern peninsula of Michigan the fossils characteristic of the Severn River limestone overlie those containing *Virgiana mayvillensis* Savage, the latter being characteristic of the uppermost layers of the Mayville limestone in eastern Wisconsin.

The Port Nelson and Severn River formations are regarded as northern or Arctic invasions, while the Brassfield is regarded as a southern invasion. Both, however, are regarded as belonging to the Alexandrian division of the Silurian of Savage. Under these circumstances, the apparent occurrence of a species

in the Port Nelson formation of the Hudson Bay area congeneric with *Osbornoceras swinnertoni* of the Brassfield of southwestern Ohio is of considerable interest.

In the northern peninsula of Michigan the equivalent of the Severn River formation is known as the Burnt Bluff formation. The only cephalopod known hitherto from the Severn River formation of the Hudson Bay area was *Phragmoceras severnense* Foerste. Here *Laphamoceras vantuyli* is added. Unfortunately the structure of the interior of the latter is unknown.

Nine species are known from the overlying Ekwan River formation of the Hudson Bay area, and none is added here. Savage correlated this formation with the Manistique of northern Michigan, though its cephalopods suggest the upper part of the Burnt Bluff formation.

From the Attawapiskat formation 22 species of cephalopods were known, and two new species are added here. This formation appears to correspond approximately to the Racine in the presence of such genera as *Pentameroceras*, *Octameroceras*, and *Phragmoceras*, but not a single species of cephalopod can be identified definitely from both. Moreover, the Ekwan and Attawapiskat formations are regarded as northern invasions, while the typical Racine is not known north of the Milwaukee area of Wisconsin. The Racine, on the contrary, is represented by numerous identical species in the Cedarville formation of southwestern Ohio, and there are closely affiliated faunas in northwestern Ohio, southern Ontario, and northwestern New York. The known distribution of the Racine fauna is distinctly south of the Canadian shield, nothing similar to this fauna being known at present anywhere in subarctic or arctic areas.

1. **Orthoceras (?) attawapiskatense** new species

(Plate I, Fig. 7; Text Fig. 3)

The holotype is a small fragment of a conch including only a single camera and part of a second camera, but the septa of these two camerae are so peculiar in form as to provide a ready means of identification of the species. Each of the two camerae is about 6 mm. long. The cross section is circular; the diameter being 23 mm. The sutures of the septa appear straight and directly transverse. The septa are funnel-shaped, the sides diverging from each other at an angle of 56 degrees. The vertical length of these funnels is 17 mm. The smallest diameter preserved at their base is 5.5 mm. The center of this basal part is 8 mm. from the nearest wall of the conch, or 3.5 mm. from the center of the conch. In consequence, one side of the funnel is 20 mm. long, while the length of the opposite side is about 15 mm. Smoothing the

basal part of the funnel reveals a ring-like structure 4 mm. in diameter. This may indicate the size of the siphuncle, but the latter is not outlined definitely. The surface of the shell apparently was smooth. The rate of enlargement of the conch can not be determined with accuracy, but it appears to have been small.

Occurrence—Ekwan River, west of the northern end of James Bay, Canada, 38 miles above the mouth of this river, and two miles above the mouth of Strong River, half a mile below locality 903 of Savage and Van Tuyl. From the Attawapiskat limestone. Collected by T. E. Savage.

Remarks—The funnel-like form of the septa is anomalous among orthoceroids. At first glance it resembles the pseudosepta figured by Barrande in the case of various Silurian species found in Bohemia, but in the Hudson Bay specimen this form is characteristic of the septa themselves. The siphuncle is exposed only in cross section at the base of one of the funnels. Its segments are assumed to be nearly cylindrical, if enlarged at all within the camerae.

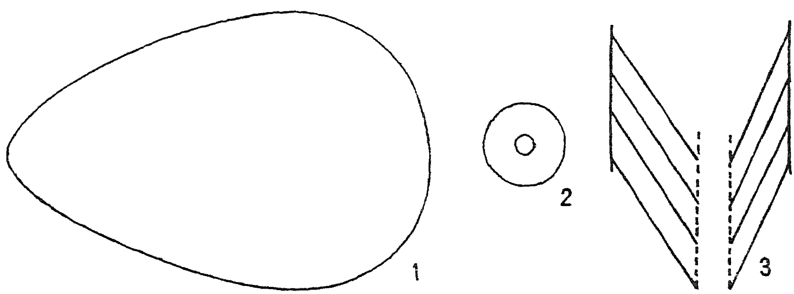


FIG. 1. *Osbornoceras swinnertoni;* cross-section of conch.
FIG. 2. *Spyroceras savagei;* cross-section showing siphuncle.
FIG. 3. *Orthoceras attawapiskatense;* vertical section showing septa and siphuncle.

2. **Spyroceras (?) savagei** new species

(Plate I, Figs. 3, 4; Text Fig. 2)

The holotype is 34 mm. long, 13 mm. of this length belonging to the living chamber. Its lateral diameter enlarges from 11.5 mm. near its base to 13.5 mm. at a point 25 mm. farther up. At the upper point mentioned its dorsoventral diameter is 2.5 mm., the conch being slightly depressed in that direction. At the top of the phragmacone, where its lateral diameter is 13 mm., there are 5 camerae in a length of 14 mm. The sutures of the septa are directly transverse. At the base of the specimen, the concavity of the septum is 1.6 mm. The diameter of the siphuncle here is 2.5 mm. Its segments are cylindrical in form, and there is no contraction at the septal necks. The location of the siphuncle is central. The surface of the shell is striated conspicuously both vertically and transversely. The vertical striae or ribs are more prominent, rising higher than the transverse ones. The more prominent of these number about 40 or 45 within the circumference of the conch.

On some parts of the surface there are less prominent vertical striae, alternating with the more prominent ones. Not enough of the surface of the shell is preserved to determine to what extent this alternation takes place. At one point, where 4 vertical striae occur in a width of 2.25 mm., there are 6 transverse ones in a length of 2.5 mm. The latter are less elevated, and hence less conspicuous. There are no distinct annulations, as in typical *Spyroceras*. Such annulations as exist are so faint as to be almost obsolete. They can be counted only along the living chamber, where the crests of 4 annulations occur in a length of 12.5 mm., the diameter of the conch here being about 13.5 mm.

Occurrence—Severn River, southwest of Hudson Bay, in the northern part of the Province of Ontario, Canada; near Limestone Island. From the Attawapiskat limestone. Collected by T. E. Savage.

Remarks—Among species already described, the one most nearly resembling this Hudson Bay specimen is the one described by Barrande[1] under the name *Orthoceras patronus* from the Devonian of Konieprus, Bohemia. In this Bohemian species the annulation is only slightly more distinct. The vertical ribbing or striation is closely similar, but the specimen figured first has more numerous transverse raised lines.

3. **Laphamoceras (?) vantuyli** new species

(Plate I, Figs. 5, 6)

Conch 48 mm. long, measured along its convex ventral outline. The radius of curvature of its convex ventral outline is about 35 mm. The specimen is crushed laterally. In its present condition its dorsoventral diameter increases from 7.5 mm. at its base to 15 mm. at a point 38 mm. farther up. At this upper point its present lateral diameter is 11 mm., but originally the lateral compression of the conch probably was moderate. Sutures of septa can be detected only between 8 and 19 mm. above the base of the specimen. At a dorsoventral diameter of 11 mm. there are about 7 camerae in a length of 10.5 mm. ventrally. The sutures of these septa are relatively straight and rise but slightly in a ventrad direction. No trace of the siphuncle is exposed, though, from the narrowness and depth of the hyponomic sinus this siphuncle is assumed to have been located close to the ventral outline of the conch. The length of the living chamber is unknown. The surface of the shell is both banded and striated transverse, the two types of ornamentation being parallel to each other. These markings are well preserved along the upper half of the specimen. Laterally they are almost straight, apparently rising in a ventrad direction. On approaching the ventral outline, however, they curve rapidly and increasingly downward, showing former locations of the hyponomic sinus. Along the upper part of the conch this sinus was V-shaped, about 6.5 mm. wide and 2 mm. deep, its basal outline rather narrowly rounded. There is a tendency toward angulation along the median part of the ventral side of the conch. Here the transverse bands tend to remain distinct, while the transverse striae become less sharply defined, or become obsolete locally.

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[1]Joachim Barraude. Systeme silurien du centre de la Boheme, Vol. 2, Pl. 275, Figs. 20–28 (1868).

Occurrence—From a loose boulder of Severn River limestone, presumably from Severn River, southwest of Hudson Bay. Collected by T. E. Savage.

Remarks—The genus *Laphamoceras* was founded on an Ordovician species, *Cyrtoceras tenuistriatum* Hall, from the Platteville member of the Black River. In it there are numerous closely crowded transverse striae which curve downward ventrally into a distinct V-shaped sinus. The resemblance of the Hudson Bay specimen to the Black River genotype probably is confined to its external features.

OSBORNOCERAS new genus

Genotype: *Osbornoceras swinnertoni* Foerste.

Cyrtoceracones cuneate-ovate in cross section, narrowly rounded ventrally, much more broadly rounded dorsally. Sutures of septa rising distinctly higher ventrally than dorsally. Siphuncle located near the ventral outline of the conch but not in contact with the latter; segments elongated vertically, nearly twice as long as wide, enlarging only moderately within the camerae, their dorsal outlines nearly straight, their ventral outlines distinctly though moderately convex. Living chamber contracting both dorsoventrally and laterally toward the aperture; lateral margins of the aperture curving upward, sloping strongly downward ventrally, indicating a relatively deep and narrow hyponomic sinus. Dorsal side of aperture uncertain.

Known at present only from the Alexandrian division of the Silurian.

4. **Osbornoceras swinnertoni** n. sp.

(Plate I, Figs. 1, 2; Text Fig. 1)

Specimen 126 millimeters long in a direct line, but about 162 mm. long when measured along its convex ventral outline. The radius of curvature of this ventral outline is 75 millimeters along the phragmacone and approximately the same along the living chamber. The corresponding radius of curvature of the concave dorsal outline is 50 mm. The maximum length of the living chamber along the median part of its lateral side is 67 mm. The dorsoventral diameter of the conch enlarges from 38 mm. at the base of the specimen to 55 mm. at the base of the living chamber, which is 105 mm. farther up when measured along its ventral outline. Apparently there is a slight contraction dorsoventrally along the upper part of the living chamber, but the ventral outline of this part of the chamber is not preserved. The lateral diameter of the conch enlarges from about 22.5 mm. at the base of the specimen to 38 mm. at the base of the living chamber, contracting to 32 mm. at its top. The cross section of the conch is cuneate. At the base of the living chamber, where its dorsoventral diameter is 55 millimeters, the maximum lateral diameter of the conch is located 20 mm. from its concave dorsal outline. The dorsal side of the cross section of the conch at the base of the living chamber has a radius of transverse curvature of 20 mm. The corresponding radius of transverse curvature of its narrow ventral edge is 5 mm. The ventrolateral sides are strongly flattened and converge

strongly toward the ventral outline of the conch. The number of camerae in a length equal to the dorsoventral diameter of the conch varies from 6 at a diameter of 49 mm. to a little over 7 at a diameter of 55 mm. The sutures of the septa curve downward laterally, their maximum downward curvature being located at the maximum lateral diameter of the conch. In a dorsad direction these sutures rise only slightly. In a ventrad direction they rise at an increasing rate on approaching the base of the living chamber, attaining an elevation of 10 or 12 mm. above the lowest part of their course at the top of the phragmacone. The passage of the siphuncle through the septum at a point 50 mm. beneath the ventral side of the base of the living chamber is 2 mm. in diameter, enlarging to 4 mm. within the camerae. The septal necks are about 1 mm. long, and contract strongly along their dorsal sides, but much less ventrally. The dorsal outline of the connecting rings is almost straight, but their ventral outline is distinctly convex. Faint traces of transverse undulations of growth cross the surface of the cast of the interior of the living chamber. These undulations curve upward along the lateral sides of the chamber, reaching their greatest elevation near the maximum lateral diameter of the conch. Thence they curve downward about 20 mm. in a ventrad direction, but only slightly in a dorsad direction. From this it is assumed that the hyponomic sinus was long, deep, and narrow. The shell appears to have attained a thickness of 1.5 mm. along the dorsal side of the living chamber, thinning to less than half a millimeter ventrally. The surface of the shell apparently was smooth.

Occurrence: From the Brassfield limestone, in the quarry of the Southwestern Portland Cement Company, about one-third of a mile southeast of Osborn, in the northwestern corner of Greene County, Ohio. Collected by Theodore Sawyer and donated by Prof. A. C. Swinnerton. U. S. National Museum No. 91091.

5. **Osbornoceras (?) savagei** n. sp.

(Plate II, Fig. 1)

Specimen 120 mm. long in a direct line, but about 131 mm. long when measured along its ventral outline. Along this ventral outline the phragmacone occupies a length of 57 mm., and the living chamber a length of 74 mm. as far as the lower margin of the hyponomic sinus. The radius of curvature of the convex ventral outline is 100 mm. The dorsoventral diameter of the conch enlarges from 44 mm. at its base to 50 mm. at the base of the ventral side of the living chamber, to 51 mm. at a point 45 mm. farther up, and then diminishes to 45 mm. at the lower margin of the hyponomic sinus after an additional interval of 29 mm., the dorsoventral contraction here being due chiefly to a slight incurvature of the ventral outline of the chamber. The original cross section of the specimen is assumed to have been similar to that of the genotype, *Osbornoceras swinnertoni*, with the general form cuneate, the dorsal side more broadly rounded, and the ventrolateral sides converging strongly toward the much more narrowly rounded ventral part of the section. At present, however, this cross section is more

compressed laterally, especially along its dorsal side, so that the lateral diameter of the conch is estimated at 18 mm. at its base, and increases thence to about 24 mm. at a point 25 mm. above the base of the living chamber, diminishing to about 18 mm. at the aperture. Along the ventral side of the lower part of the living chamber the more narrowly curved part of the ventral side of this cross section has a radius of curvature of 3 or 4 mm., while dorsally the corresponding radius is approximately 7.5 mm. In consequence, the cross section of this specimen is more lenticular than cuneate, but with the dorsal side more broadly rounded. Nine camerae are preserved. Of these, the upper three occupy a total length of 18 mm. ventrally, the intermediate three of 22 mm., and the lower three of 17 mm. The sutures of the septa curve only slightly downward along the dorsal half of their course, but rise distinctly along their ventral half, the amount of this rise equalling about 9 mm. along the upper part of the phragmacone. The siphuncle is not preserved but is assumed to be located as in the genotype. The lateral margin of the aperture appears to rise upward, attaining its greatest elevation dorsad of the center of the conch. Its downward curvature in a ventrad direction equals about 8 mm., indicating the former presence of a long and narrow V-shaped hyponomic sinus. In a dorsad direction the downward curvature of this margin appears much less. The surface of the shell is not preserved distinctly, but appears to have been smooth.

Occurrence: From 4 miles above the Lower Rapids of the Nelson River, 18 miles below the mouth of Limestone River; from the Port Nelson limestone.

Remarks: Osbornoceras savagei differs from *Osbornoceras swinnertoni* in the smaller lengthwise curvature of its conch, the smaller rate of enlargement of its phragmacone dorsoventrally, the greater length of its living chamber, and the less rapid rise of the sutures of its septa along the ventral half of their course. The more narrow rounding of the dorsal side of its cross section is ascribed to compression of the conch after the death of the animal.

6. **Phragmoceroid** (?)

(Plate II, Fig. 2)

A second specimen, from the same locality and horizon as *Osbornoceras savagei*, appears to be more erect, its right outline as figured being slightly convex. The living chamber is shorter and the left part of its upper margin appears contracted, as though outlining the dorsal lobe of the aperture of some phragmoceroid. However, there is no evidence that the right side of its aperture projected in the form of a spout similar to the hyponomic sinus of phragmoceroids. Therefore the systematic position remains in doubt. It is figured here in contrast with typical *Osbornoceras savagei*, both being from the Port Nelson limestone, 4 miles below the Lower Rapids of the Nelson River.

OXYGONIOCERAS Foerste

Genotype: *Trochoceras oxynotum* Barrande, Systeme Silurien du Centre de la Boheme, Vol. 2, p. 91, Pl. 14, Figs. 1–11 (1867); *Oxygonioceras oxynotum* Foerste, Jour. Sci. Labs. Denison Univ., Vol. 21, p. 62 (1926); Vol. 21, p. 375, Pl. 42, Figs. 1 A-E (1926).

Cross section of conch ovate cuneate, with the ventral side narrowly but not sharply rounded, the dorsal side much more broadly rounded. Conch curved lengthwise, the siphuncle located on its convex outline. In the genotype the segments of the siphuncle enlarge strongly within the camerae, their lateral diameter equallin about 1.7 times their height. This genotype is from the Middle Silurian of Bohemia, at present a part of Czechoslovakia.

7. **Oxygonioceras (?) cuneatum** (Whiteaves)

Cytoceras (?) *cuneatum* Whiteaves. Geol. Surv. Canada, Vol. 3, Pt. 4, p. 282 (1906); Ottawa Naturalist, Vol. 20, p. 133. Text Figs. A, B, (1906).
Oxygonioceras cuneatum Foerste. Jour. Sci. Labs., Denison Univ., Vol. 21, p. 63 (1925)

The holotype is from the Silurian at Stonewall, Manitoba. Regarding the location of its siphuncle Whiteaves stated: "Shape and position of siphuncle not very clearly defined in the only specimen collected, though at the smaller end thereof there are indications that it was eccentric and placed a little on the ventral side of the center, as represented in Fig. B." In this Figure, published in the *Ottawa Naturalist*, the dorsoventral diameter of the conch is drawn as 27.5 mm. long, the passage of the siphuncle through the septum being almost 2 mm. in diameter, and its center being 10.5 mm. from the cuneate ventral side of the conch.

Unfortunately this holotype has been lost, so that the subcentral location of the siphuncle can not be verified. Usually cyrtoceroids with a subangular ventral outline have the siphuncle located near the convex ventral outline of the conch, and a subcentral location of the siphuncle should not be accepted unless clearly indicated. Whiteaves's statement that the shape and position of the siphuncle are not very clearly indicated increase the uncertainty as to the subcentral location of the latter. In other words, there is a possibility that the siphuncle in this species was located near its subangular convex outline, as in *Oxygonioceras*. Should, however, the subcentral location of the siphuncle ever be verified then the Stonewall specimen would necessarily be excluded from *Oxygonioceras*.

8. **Oxygonioceras (?) wabashense** n. sp.

Oxygonioceras cf. *cuneatum* Foerste. Notes on cephalopod genera; chiefly coiled Silurian forms. Jour. Sci. Lab., Denison Univ., Vol. 21, p. 63, Pl. 21, Figs. 1A, B, C, (1925).

The specimen from the Niagaran at Wabash, Indiana, differs from the species originally described by Whiteaves as *Cyrtoceras cuneatum* in its less rapid rate of curvature lengthwise, and in the greater number of camerae in a length equal to the dorsoventral diameter of the conch. In its present condition, the dorsal side of the cross section of the conch

is much more angular along its median line, but this feature may be due in part to lateral compression of the conch after the death of the animal.

B. BRASSFIELD CRINOIDS

Unidentifiable fragments of crinoids are common in the upper part of the Brassfield formation in Ohio and Kentucky east of the Cincinnati anticline; however, remains at least generically identifiable are rare, and specimens suitable for the erection of species are still rarer. The little that was known in 1919 was included in a paper on the Echinodermata of the Brassfield (Silurian) Formation in Ohio published by the writer in volume 19 of the Denison University Bulletin, Journal of the Scientific Laboratories.

Most characteristic of these crinoidal remains are numerous detached flat columnals, often attaining diameters of 12 or 13 mm., but occasionally equalling 22 mm. and even 28 mm. in diameter. These columnals are specially common at the top of the Brassfield. Rarely these columnals are found still forming a continuous stem. The stem illustrated in the publication cited above was a little over 150 mm. long and formed a loose flat coil 41 mm. in diameter with its smaller end at the center. This stem enlarged in diameter from slightly over 1 mm. at its smaller end to about 8 mm. at its top. Short strands of larger columnals also occur, evidently fragments of much longer stems. Unfortunately, no calices which could belong to these stems have been found. The loose columnals occur from Dayton, Ohio, southward as far as the Cumberland River, in the southwestern part of Pulaski County, Kentucky.

A single stem, described as *Eomyelodactylus rotundatus* Foerste, was found on Caesar Creek, nearly five miles southeast of Xenia, Ohio. Parts of calices, described as *Dimerocrinus* (?) *vagans* Foerste, were found seven miles northwest of Xenia, at a locality reached by going from Byron one mile east and then one mile south, east of the road. Here also was found the specimen described as *Stereoaster squamosus*, but the latter at present is regarded as merely the badly weathered under side of the tegmen of some unknown crinoid.

Fragments of calices have turned up more frequently in the upper part of the large quarry at Centerville, Ohio, than elsewhere. Occasionally a good head is found. One of these was described in the publication mentioned above merely as

Clidochirus sp., since it was discovered before publication that Springer already had figured another specimen belonging to the same species under the name *Clidochirus americanus*. At present three specimens of this species are in the U. S. National Museum.

Among the other specimens figured from the Centerville quarry in the publication cited above the one doubtfully identified as a Platycrinid may be a *Patelliocrinus*, and that doubtfully referred to *Cyathocrinus* may be a *Pycnosaccus*. Until better preserved specimens are found their exact relationship must remain in doubt.

Recently two specimens were found in the upper part of the Brassfield formation at Centerville which evidently belong to the Calceocrinidae. Both are alike in having a median arm which branches on the fifth primibrach. However, in the smaller specimen this arm branches again on the third secundibrach, while in the larger specimen this branching can not take place earlier than the fourth secundibrach, and may take place later, as far as can be determined from the specimen at hand in which the sutures above the fourth secundibrach are poorly defined. In the smaller specimen the lateral arms present five erect branches of the type described in full by Springer for the genera *Calceocrinus* and *Halysiocrinus*. In the larger specimen, however, it is impossible to determine definitely whether the lateral arms branch as in *Eucheirocrinus* or as in *Calceocrinus*. Of the branches of the lateral arms only those nearest the median arm are preserved distinctly, and these in their present state of preservation could be referred to *Eucheirocrinus* almost as readily as to *Calceocrinus*. In the smaller specimen the brachs of the median arm are much more compressed laterally than in the larger one; moreover the upper parts of both the median and the lateral arms curve more strongly toward the posterior side of the crown. The sutures separating the basals are poorly indicated, but apparently there are only three basals. In both specimens the two segments of the radial supporting the median arm appear to be in narrow contact with each other. In the smaller specimen the columnals of the stem appear to become moderately longer in a distal direction, while those of the larger specimen are subequal.

Owing to the differences here noted the smaller specimen is described as *Calceocrinus centervillensis*, while the larger one is separated as *Calceocrinus* (?) *incertus*.

9. **Calceocrinus centervillensis** new species

(Plate II, Figs. 3, 4)

The holotype is 17.5 mm. long, 5.5 mm. of this length belonging to the calyx. Apparently only 3 basals are present, no suture being detected along the middle of the median triangular basal. The apex of this plate is very near the base of the stem, but apparently it is not in actual contact with the latter. The two segments of the radial supporting the median arm apparently are in very narrow contact with each other, but sutures here are very indistinct. The brachials of the median arm are strongly convex transversely and their outer surface is minutely granulate. This arm branches on its fifth primibrach. Only the right branch is preserved and this branches on its third secundibrach. The main axis of the lateral arms rises at a strong angle and gives rise to 5 erect branches. These erect branches divide heterotomously, one of the two branches usually being distinctly smaller than the other. These smaller branches are formed alternately first on one side of the larger branch then on its opposite side. Unfortunately, in the specimen at hand, only glimpses of the smaller branches are secured as a rule, and not infrequently the sutures between the brachs are not distinct. The stem is preserved for a length of 5.5 mm. The columnals apparently enlarge in a distad direction.

Occurrence: Quarry northeast of Centerville, Ohio. From the clay layers at the top of the Brassfield formation. U. S. National Museum, No. 91093.

10. **Calceocrinus (?) incertus** new species

(Plate II, Figs. 5, 6, 7, 8)

The holotype is 28 mm. long, 7.5 mm. of this length belonging to the calyx. This calyx narrows from a width of nearly 7 mm. near its base to 6 mm. a short distance beneath its top. The gap between the basals and radials is lenticular in outline and is 6 mm. wide and 1.5 mm. long. Apparently there is only a single median triangular basal. The two segments of the radial supporting the median arm apparently meet at a point. This median arm branches on its fifth primibrach. Both branches present a straight transverse suture at the top of the third secundibrach; each may have branched on the fourth secundibrach, but that is uncertain. The proximal erect branch of the right lateral arm branches several times, but it is impossible to determine whether this branching is similar to that of *Calceocrinus* or of *Eucheirocrinus*. Apparently the primary part of this right lateral arm arises as in *Calceocrinus centervillensis*, giving off vertical branches, but this can not be determined definitely. The brachials of both the median and lateral arms are less convex than in the preceding species. The surface of both calyx and arms is granulate, the granules being preserved locally. The stem is preserved for a length of 8 mm. Throughout this length its segments are short and disc-like, the crests of 5 columnals occurring in a length of 2 mm., the diameter of the stem being 1.6 mm.

Occurrence: Quarry at the northeast margin of Centerville, Ohio. From clay layers at the top of the Brassfield formation. U. S. National Museum, No. 91092.

EXPLANATION OF PLATES

Plate I

Figs. 1, 2. *Osbornoceras swinnertoni* Foerste. 1, lateral view with ventral outline on left; 2, dorsoventral section through siphuncle, oriented as in Fig. 1. Osborn, Ohio; from Brassfield limestone. See also Text Fig. 1. U. S. National Museum, No. 91091.

Figs. 3, 4. *Spyroceras* (?) *savagei* Foerste. 3, natural size; 4, same, enlarged three diameters, slightly turned toward right. Severn River, near Limestone Island, Hudson Bay area; from Attawapiskat limestone. See also Text Fig. 2. Savage collection.

Figs. 5, 6. *Laphamoceras* (?) *vantuyli* Foerste. 6, lateral view with ventral outline on left; 6, oblique dorsal view showing downward curvature of transverse striae along former locations of hyponomic sinus. Loose boulder, Severn River, Hudson Bay area; from Severn River limestone. Savage collection.

Fig. 7. *Orthoceras* (?) *attawapiskatense* Foerste. Lateral view, showing funnel-shaped septum at its base. Ekwan River, two miles above Strong River, Hudson Bay area; from Attawapiskat limestone. See also Text Fig. 3. Savage collection.

Plate II

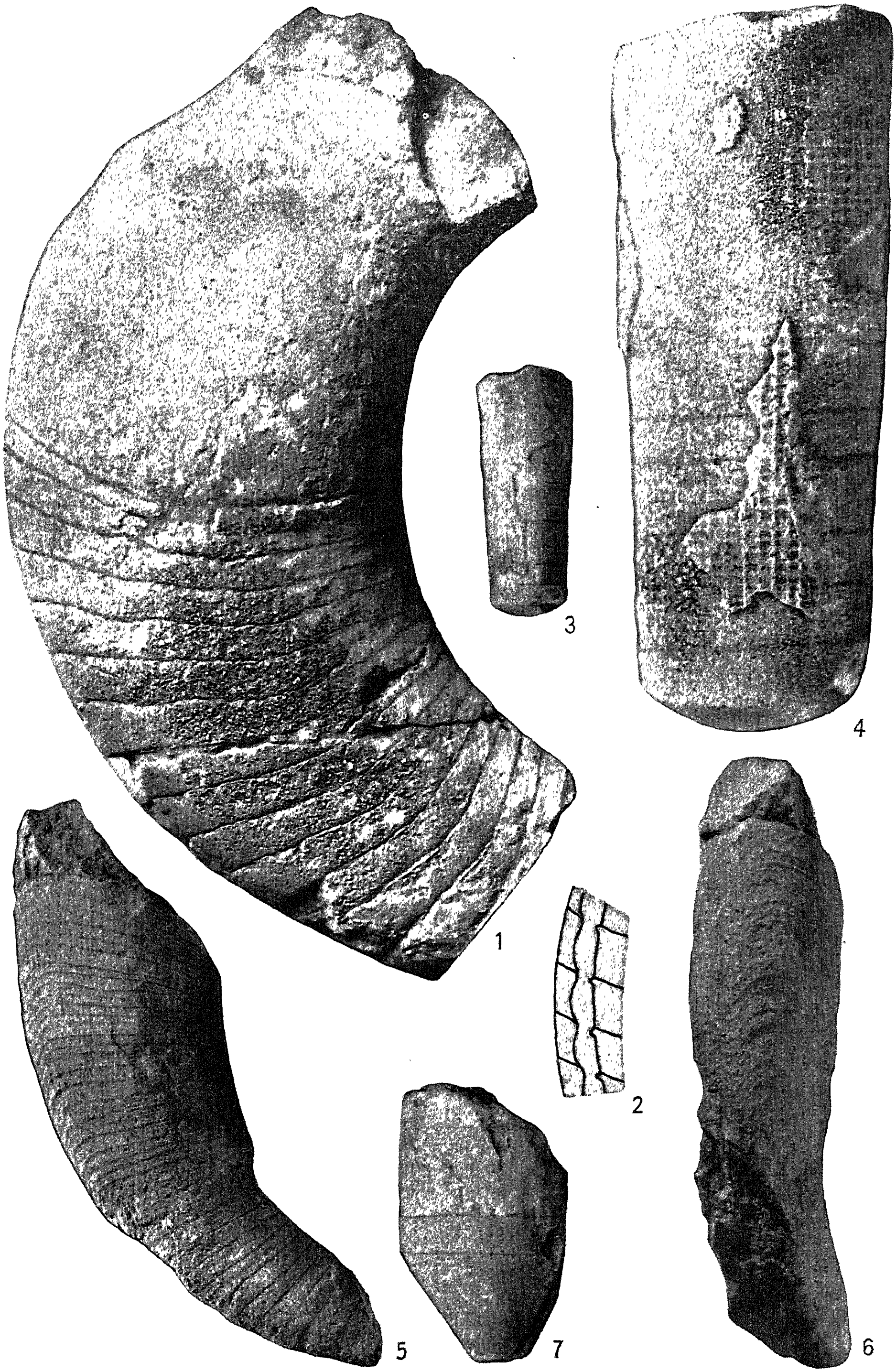
Fig. 1. *Osbornoceras* (?) *savagei* Foerste. Lateral view with left outline regarded as ventral. Four miles above Lower Rapids of Nelson River; from Port Nelson limestone. Savage collection.

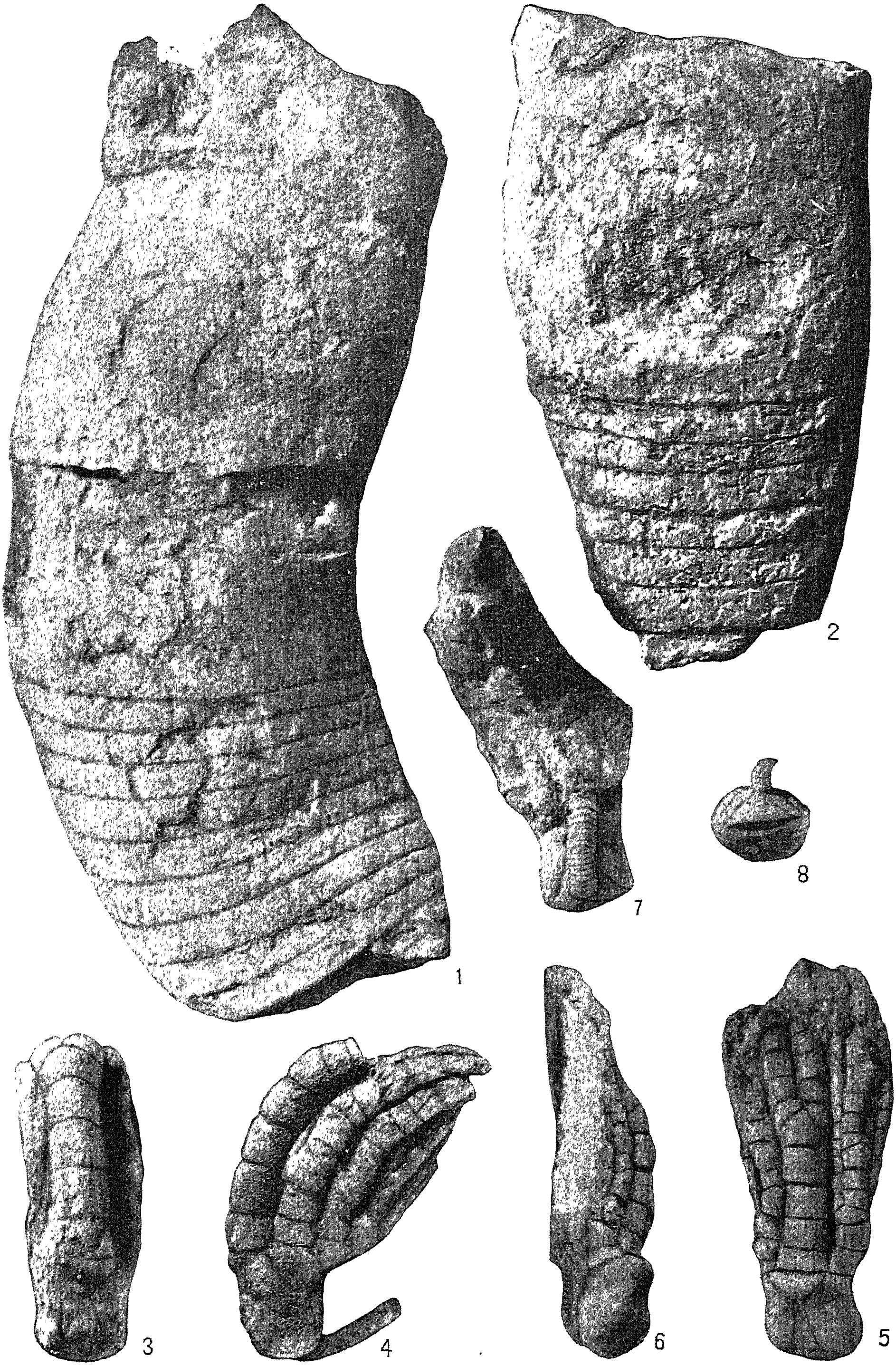
Fig. 2. *Phragmoceroid* (?). Lateral view, oriented as in preceding figure. Four miles above Lower Rapids of Nelson River; from Port Nelson limestone. Savage collection

Figs. 3, 4. *Calceocrinus centervillensis* Foerste. 3, showing calyx and median arm; 4, lateral view with median arm on left; also 5 vertical branches of right lateral arm. Quarry on northeast margin of Centerville, Ohio; from top of Brassfield formation. U. S. National Museum, No. 91093.

Figs. 5, 6, 7, 8. *Calceocrinus incertus* Foerste. 5, showing calyx, median arm, and adjacent parts of the two lateral arms; 6, left side, showing calyx with stem on left side, and with median arm on right outline, also adjacent part of left lateral arm; 7, posterior side of calyx showing the stem attached to its base and curved upward parallel to the calyx; 8, calyx viewed from beneath and showing the gap at the hinge between the basals and the radials, stem attached to the basals and curving strongly upward, parallel to the posterior side of the calyx. Quarry at northeastern margin of Centerville, Ohio; from the top of the Brassfield limestone. U. S. National Museum, No. 91092.

PLATE I

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NOTES ON THE CARABIDAE OF OHIO

I. Tetragonderus fasciatus Hald., Bembidium laevigatum Say, and Geopinus incrassatus (Dej.) in Ohio (Coleoptera—Carabidae)

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Holmesville, Ohio

While perusing some of the earlier volumes of Entomological literature, one is impressed by the wealth of observations recorded as notes, particularly upon the abundance and distribution of various species of insects. It is regretable that such a faculty for observation and writing of such notes is lacking in the majority of the present day workers in entomology, although there appears to be an increase in the publication of such records in recent years.

It is with this thought in mind, that the information here presented may be of use to others in not only extending the knowledge of the fauna in areas similar to Ohio, but also to extend and enlarge the collections already extant in this state, rather than the assumption that these records present a complete picture of the distribution of these species in Ohio.

On June 24, 1933, while on a collecting trip in Hocking County, the first specimens of *Tetragonderus fasciatus* Hald. were observed in their natural habitat. This occurred quite accidentally while seated upon a bank of white sand along Salt Creek, about three miles west of South Bloomingville, resting from the exertions and the heat of the day. It was noticed that when the base of the clumps of grass and other plants growing in the sand were disturbed, a small whitish-appearing beetle, later identified as the above species, scurried to a new hiding place. The smallness of the insects and the instability of the loose sand, made capture rather difficult without injury to the specimen. A rather intensive search resulted in the capture of six specimens. Upon returning the next day to same locality, four more specimens were secured.

Prior to this date, only five specimens of *T. fasciatus* had been taken. The first of these was collected among stones close to the water edge, along the Portage River, two miles northwest of Pemberville, in Wood County, Ohio, on June 13,

[1]Joint authors.

1931. Two other specimens were taken on May 25, 1933, and the remaining two on June 5, 1933, in Lucas County (Adams Township, Section 23), along a gravel road, about two miles north of Maumee. These specimens in both instances were attracted to the headlamps of the automobile, while parked collecting other insects.

Since this observation was made in Hocking County, some 122 specimens have been taken. The largest collection was made in this same county, just south of Logan, along the west bank of the Hocking River, just south of the Chesapeake and Ohio railroad bridge (Falls Township, Section 14), on August 5, 1934, when 54 specimens were collected. In Gallia County, along the sandy banks of a small stream a few miles north of Vinton (Huntington Township, Section 13), 40 individuals of this species were secured on August 7, 1934. The only other locality where this species was noted in rather abundant numbers was in Holmes County along Paint Creek, a few miles south of Holmesville (Prairie Township, Section 9), where 14 specimens were collected on August 3, 1934. One specimen was taken in Fairfield County (Berne Township), near Sugar Grove, along Hocking River, on June 1, 1935.

While examining material in this family in other collections made in this state, only seven other specimens of this species were noted. One was in the Dury collection at Cincinnati, and was labeled Cincinnati, Ohio, 6–27–5, no collector indicated. Mr. Ralph Dury, Director of the Cincinnati Museum of Natural History, states that this species is quite abundant in the vicinity of this city in habitats similar to that described above. Four are in the collection of the Ohio Agricultural Experiment Station, at Wooster, Ohio, one from Ashtabula, Ohio, and three from Cedar Point, Ohio, and two are in the collection of the Ohio University at Athens, Ohio, collected by Dr. Stehr on white sand along Hocking River at Athens.

In the records of the Ohio Biological Survey there is a record of this species being taken by Mr. Sim in Erie County, at Cedar Point, on July 15, 1912. There is no statement as to the number collected, nor were any specimens seen.

The following tabulation summarizes the present knowledge of the distribution of this species in Ohio, so far as it is known:

ATHENS COUNTY, OHIO.
Athens, Ohio, May 21, 1935.................... 2 sp. W. C. Stehr.
ASHTABULA COUNTY, OHIO.
Ashtabula, Ohio, 6–9–1899.................... 1 sp. (?).

ERIE COUNTY, OHIO.		
Cedar Point, Ohio, July 15, 1912	?	Sim (O. B. S. record).
Cedar Point, Ohio, 7–10–1899	3 sp.	(?)
FAIRFIELD COUNTY, OHIO.		
Berne Twp., Sugar Grove, June 1, 1935	1 sp.	R. T. Everly.
GALLIA COUNTY, OHIO.		
Huntington Twp., Sec. 13, Aug. 7, 1934	40 sp.	L. W. & R. T. Everly.
HAMILTON COUNTY, OHIO.		
Cincinnati, Ohio, 6–27–5	1 sp.	(?).
HOCKING COUNTY, OHIO.		
Scenic Inn, near Ash Cave, Aug. 5, 1934	4 sp.	L. W. & R. T. Everly.
Conckle's Hollow, Aug. 6, 1934	1 sp.	L. W. & R. T. Everly.
Falls Twp., Sec. 14, Aug. 5, 1934	54 sp.	L. W. & R. T. Everly.
Salt Creek Twp., Sec. 24, June 24, 1933	6 sp.	L. W. & R. T. Everly.
Salt Creek Twp., Sec. 24, June 25, 1933	4 sp.	L. W. & R. T. Everly.
HOLMES COUNTY, OHIO.		
Prairie Twp., Sec. 9, Aug. 2, 1933	3 sp.	R. T. Everly.
Prairie Twp., Sec. 9, Aug. 3, 1933	14 sp.	R. T. Everly.
LUCAS COUNTY, OHIO.		
Adams Twp., Sec. 23, May 25, 1933	2 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, June 5, 1933	2 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, Sept. 8, 1933	2 sp.	R. T. Everly.
Washington Twp., Sec. 8, in sandy tomato field, Aug. 4, 1934	2 sp.	R. T. Everly.
WOOD COUNTY, OHIO.		
Freedom Twp., Sec. 1, June 13, 1931	1 sp.	R. T. Everly.

Another species taken in close association with *T. fasciatus* was *Bembidium laevigatum* Say. This latter species was not nearly so abundant, and has been taken in habitats other than that where *T. fasciatus* is commonly found. In Hocking County, south of Logan (Falls Township, Section 14), where 54 specimens of *T. fasciatus* were collected, 7 specimens of *B. laevigatum* were also taken on August 5, 1934. In a similar habitat in Holmes County (Prairie Township, Section 9), on July 31, August 2, and August 3, 1933, six individuals of the latter species were secured. In the Dury collection there were four specimens from Cincinnati, two without dates, the others dated 7–12–5 and 7–11–13. None of the specimens bore collector labels. Mr. Ralph Dury corroborates the observation that this species occurs in a similar habitat and at the same time as *T. fasciatus*.

The first specimens of *B. laevigatum* observed were collected just north of Lake Alma in Jackson County, under stones on the western slope of a bare hill, on April 3, 1932, and on June 23, 1933, two specimens were collected in Hocking County (Salt Creek Township, Section 24), along Salt Creek, three miles west of South Bloomingville, where the largest series of this species was secured on August 5, 1934. The stream had been high recently and with the abatement of the water, had

deposited a heavy layer of silt upon the bank. This deposit dried rapidly, forming large cracks. By pressing these cracks together with the feet, a number of insects were forced out by the pressure, and among these were nine specimens of *B. laevigatum*. One individual of this species was taken on the bank of the Ohio River near the Gallipolis Airport on August 7, 1934, four specimens were secured along the banks of the Auglaize River, just north of Cascade, Ohio, in Putnam County (Perry Township, Section 21), on May 21, 1934, and in Coshocton County one was secured along the Walhonding River near Six Mile Dam near Warsaw (Bethlehem Township, central portion), and three from along the Koskosing River near its confluence with the Mohican River (New Castle Township, northwest portion), on May 25, 1935.

In addition to the specimens in the Dury collection, the following specimens have been seen. Two specimens are in the collection of the Ohio State Archaeological and Historical Society at Columbus, Ohio, one from along the Olentangy River north of the University Campus, and the other from Fairfield County (Berne Township), and one specimen labeled Columbus, Ohio, is in the Hines collection at the same place. Two are in the Ohio University collection at Athens, one from Athens, Ohio, and the other from Meigs County. In a thesis presented for the degree of Master of Science at Ohio State University in 1916 by T. L. Guyton, is recorded one specimen of this insect, collected upon milkweed in Guernsey County, Madison Township.[2]

Four of these specimens herein recorded as *B. laevigatum* show marked differences and may be characteristic enough to warrant at least a variety name. However, rather than retard the publication of this data by the necessary study required to verify these differences, they are here included as this species.

The following list summarizes the distribution of *B. laevigatum* in Ohio:

ATHENS COUNTY, OHIO.
Athens, Ohio, 4–28–34 . . . . 1 sp. H. Bauman.
COSHOCTON COUNTY, OHIO.
New Castle Twp., N. W., May 25, 1933 . . . . 3 sp. R. T. Everly.
Bethlehem Twp., C, May 25, 1933 . . . . 1 sp. R. T. Everly.

[2]Although this specimen was not seen, its identification can be reasonably assumed, as the species is very characteristic in both shape and coloration, and not easily confused with other species of Carabidae.

FAIRFIELD COUNTY, OHIO.		
Berne Twp., X-15-33	1 sp.	H. Goslin and E. S. Thomas.
FRANKLIN COUNTY, OHIO.		
Columbus, Ohio, (?)	1 sp.	(?).
Columbus, Ohio, May 27, 1933	1 sp.	William Ross.
GALLIA COUNTY, OHIO.		
Gallipolis Airport, Aug. 7, 1934	1 sp.	L. W. and R. T. Everly.
GUERNSEY COUNTY, OHIO.		
Madison Twp., (?)	1 sp.	T. L. Guyton.
HAMILTON COUNTY, OHIO.		
Cincinnati, Ohio, 7-12-'5	1 sp.	(?).
Cincinnati, Ohio, 7-11-13	1 sp.	(?).
Cincinnati, Ohio, (?)	2 sp.	(?).
HOCKING COUNTY, OHIO.		
Salt Creek Twp., Sec. 24, June 23, 1933	2 sp.	L. W. and R. T. Everly.
Salt Creek Twp., Sec. 24, Aug. 5, 1934	9 sp.	L. W. and R. T. Everly.
Falls Twp., Sec. 14, Aug. 5, 1934	7 sp.	L. W. and R. T. Everly.
HOLMES COUNTY, OHIO.		
Prairie Twp., Sec. 9, July 31, 1933	1 sp.	R. T. Everly.
Prairie Twp., Sec. 9, Aug. 2, 1933	1 sp.	R. T. Everly.
Prairie Twp., Sec. 9, Aug. 3, 1933	4 sp.	R. T. Everly.
JACKSON COUNTY, OHIO.		
Lake Alma, April 3, 1932	2 sp.	L. W. and R. T. Everly.
MEIGS COUNTY, OHIO.		
Syracuse, Ohio, 8-16-33	1 sp.	W. C. Stehr.
PUTNAM COUNTY, OHIO.		
Perry Twp., Sec. 21, May 21, 1934	4 sp.	L. W. and R. T. Everly.

On the evening of May 25, 1933, returning from a collecting trip along the Maumee River just after dark, while driving along a by-road surfaced with very fine gravel, in Lucas County (Adams Township, Section 23), several large beetles were observed in the light from the headlamps of the automobile, crawling upon the road. Upon stopping these were found to be *Calosoma calidum* Fab. and *Scarites substriatus* Hald. While these specimens were being secured, another large, robust, light brown colored beetle, later identified as *Geopinus incrassatus* (Dej.), began coming to the light in large numbers. Unfortunately the collecting jars being used were shell vials, one inch by six inches, and as these insects are rather large, the remaining vials were soon filled, some 37 specimens being taken. Upon the returning the next evening, no specimens were secured, but the night of June 3, 1933, 10 more were taken, and on June 8, 1933, 8 more were secured at the same location. During the same year 7 more individuals were collected at lights in East Toledo, Ohio, from June 5, 1933, to June 30, 1933. Of a total of 63 specimens collected in 1933 and 1934, all but one from Lake County, were taken at lights.

Dr. W. C. Stehr has taken one at Athens, Ohio, on October 29, 1931, at lights.

In addition to the last mentioned specimen, there are in the Dury collection six specimens bearing a Cincinnati, Ohio, label. Two specimens are in the collection of the Ohio State Archaeological Museum at Columbus, Ohio, one is from Cincinnati, collected by Miss Annette F. Braun on September 29, 1908, and the other is from Geauga County, taken by Mr. M. E. Crago, and three specimens in the University collection at the same location, one collected from Columbus, Ohio, on May 25, 1906, by Dr. James S. Hine, and two specimens from Geneva, Ohio, Ashtabula County, taken in June, 1909, by Mr. R. J. Sim. In the collection of the Department of Zoology and Entomology of the Ohio State University, there is one other specimen from Ashtabula County, taken by Mr. Sim, at Ashtabula, Ohio, on August 27, 1911. The records of the Ohio Biological Survey show this species as having been taken by Mr. Sim in Erie County, at Cedar Point, on July 1, 1912; there was no indication of the number of specimens.

The following summarizes the known distribution of *G. incrassatus* in Ohio:

ATHENS COUNTY, OHIO.		
Athens, Ohio, 10-29-1931	1 sp.	W. C. Stehr.
ASHTABULA COUNTY, OHIO.		
Geneva, Ohio, 6-09	2 sp.	Robt. J. Sim.
Ashtabula, Ohio, Aug. 27, 1911	1 sp.	R. J. Sim.
ERIE COUNTY, OHIO.		
Cedar Point, Ohio, July 1, 1912	(?)	Sim (O. B. S. record).
FRANKLIN COUNTY, OHIO.		
Columbus, Ohio, V-25-06	1 sp.	Jas. S. Hine.
GEAUGA COUNTY, OHIO.		
(?), 1934 (?)	1 sp.	M. E. Crago.
HAMILTON COUNTY, OHIO.		
Cincinnati, Ohio, Sept. 29, 1908	1 sp.	Annette F. Braun.
Cincinnati, Ohio, (?)	6 sp.	(?).
LAKE COUNTY, OHIO.		
Perry Twp., N. E. on beach, June 17, 1934	1 sp.	L. W. Everly.
LUCAS COUNTY, OHIO.		
Adams Twp., Sec. 23, May 25, 1933	37 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, June 3, 1933	10 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, June 8, 1933	8 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 5, 1933	2 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 6, 1933	3 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 7, 1933	1 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 30, 1933	1 sp.	L. W. and R. T. Everly.
PUTNAM COUNTY, OHIO.		
Ottawa, Ohio, May 19, 1934	1 sp.	R. T. Everly.
Ottawa, Ohio, June 1, 1934	1 sp.	R. T. Everly.

For invaluable service rendered through making available other collections and records of Ohio Carabidae, thus enlarging our knowledge of the distribution of these and of other species, which records in Ohio it is hoped to assemble and present at a later date, acknowledgment is hereby made to the following: Mr. Ralph Dury, Director of the Cincinnati Museum of Natural History; Mr. J. N. Knull, Curator of Insect Collections of the Department of Zoology and Entomology at the Ohio State University; Mr. Harold L. Madison, Director of the Cleveland Museum of Natural History; Dr. August E. Miller, of Zanesville, Ohio; Professor Herbert Osborn, Director of the Ohio Biological Survey; Mr. John C. Pallister, formerly Curator of Insects at the Cleveland Museum of Natural History; Mr. Paul E. Schaefer, of the Department of Zoology and Entomology, Ohio State University; Dr. W. C. Stehr, of the Department of Biology, Ohio University, Athens, Ohio; and Mr. E. S. Thomas, Curator of Natural History, Ohio State Archaeological and Historical Museum, Columbus, Ohio.

Forest Insects

The increased study of forestry and forestry conservation problems has impressed upon many workers the great importance of training the men in these fields of specialization in forest entomology. Many courses in forest entomology have been taught using books on shade tree insects and references to scattered literature as readings for the course. Graham's "Principles of Forest Entomology" (an earlier book on this subject) deals largely with principles, and not a great deal is given on the large number of insects attacking forest or shade trees. The authors of this new textbook have brought together all the important literature on forest entomology into one large volume, and have presented it in the way that the subject is being taught at some of the universities today.

The chapter headings are as follows: Importance of Forest Entomology; Control of Forest Insects, General Considerations; Control of Forest Insects, Bark-Beetle Control; The Control of Insects Injurious to Forest Products; Bark-Beetles and Ambrosia Beetles; The Flat-Headed and Round-Headed Borers; Other Families of Beetles; The Moths and Butterflies; Sawflies, Horntails, Bees, and Ants; Aphids, Scale Insects and Others; Some Other Orders of Insects and the Mites; and Termites or White Ants. At the end of the book is an appendix consisting of the more important hardwood and coniferous trees of the United States and some of their principal insect enemies. The book is well indexed to both common and scientific names. Following each chapter is a list of the more important references which pertain to the particular subject being discussed.

The book is well illustrated, many of the drawings being used for the first time. There seems to be a slight tendency towards the treating of the western insects more thoroughly. Although a very large number of insects are mentioned in the book and the authors are to be complimented for their work, the writer feels that more detailed information on some of the more important insects would have been a valuable addition. The book should serve as a useful text for forest entomology at all forestry schools. It is the most complete text on the subject at the present time.—R. H. Davidson.

Forest Insects, by R. W. Doane, E. C. Van Dyke, W. J. Chamberlin, and H. E. Burke. 463 pp. New York, The McGraw-Hill Book Company, 1936. $4.50.

ILLUSTRATIONS OF EXTERNAL ANATOMY SILPHA AMERICANA LINN. (SILPHIDAE, COLEOPTERA)[1]

NORRIS D. BLACKBURN

This paper on the external features of *Silpha americana* Linn. is offered as a contribution to the knowledge of external anatomy of Coleoptera, and to supply a lack of available material on the external characters of this family. The Silphidae belong to the suborder Polyphaga and the superfamily Staphylinoidea. The primitive type of Polyphaga is found in its original form in the series of Staphylinoidea (Böving and Craighead, 1931).

The nomenclature followed by the writer was adopted from Snodgrass, Singh Pruthi, Crampton, and others.

The writer wishes to express his appreciation to Dr. C. H. Kennedy for the many helpful suggestions and assistance offered during the progress of this work.

GENERAL DESCRIPTION

This species is broadly oval and very flat, being adapted for crawling under objects rather than burrowing as in the case of Necrophorus. The thorax is yellow with a discal black spot. Elytra brownish with elevations much darker. The length of the adult varies from 17–20 mm.

The specimens used in this study were procured from South Bass Island in Lake Erie. Partially decayed meat or dead fish were put into cans which were sunk until the open end was flush with the surface of the ground. These were covered with leaves and examined daily. Often as many as ten individuals of *Silpha americana* were found in some cans. Other Silphidae belonging for the most part to the genus Necrophorus were collected. Several Histeridae were also found.

As material was plentiful dissections were made possible from live beetles. Specimens not used for live dissection were preserved in seventy per cent alcohol. In cases where sutures were difficult to discover the parts were boiled in a ten per cent solution of potassium hydroxide. Drawings were made under binocular using a camera lucida.

THE HEAD

The *head capsule*, from the dorsal view (Fig. 5), appears almost square, is strongly depressed, and can be retracted under the anterior margin of the pronotum until the eyes are almost hidden. Sutures in the head have disappeared or are so faint that they cannot be seen.

[1]Submitted to the Graduate School of Ohio State University in partial fulfillment of the requirements for the degree of Master of Arts.

A depressed area near the inner margin of each eye locates the internal attachments of the dorsal arms of the tentorium. The head is covered with fine pubescence and the region at the posterior margin of the eyes is covered with much longer hairs. The labrum (Lbr) is closely attached to the head capsule, there being no membrane visible externally. The eyes are quite prominent and can be seen from both the dorsal and ventral view. No ocelli are present.

The antennae (Fig. 18), composed of eleven segments and clavate, are inserted behind the base of the mandibles. The third joint is shorter than the second which is one of the key characters separating this species from *Silpha inaequalis* Fab. The segments are gradually clubbed.

The gula is the most prominent part of the ventral view of the head capsule (Fig. 6) and is separated from the gena on either side by the gular suture. It is broad at the anterior median end, narrows suddenly towards the posterior part and at the extreme posterior end broadens where it forms the ventral part of the foramen magnum.

The endoskeleton of the head (Fig. 7) consists of an anterior arm (Ant. Arm), dorsal arm (Dor. Arm), and posterior arm (Post. Arm). The anterior arms project laterally toward the mandibular articulation, and probably serve as muscle attachments for the mouthparts. The dorsal arms project latero-dorsally and fuse with the exoskeleton of the head near the inner margin of the eyes. The posterior arms extend to the lateral margin of the foramen magnum where they are thickened and articulate with the cervical sclerites.

The labrum (Figs. 8 and 9), closely joined to the head capsule, is deeply emarginate at its anterior end and densely covered with setae and fine hairs which are located in the membranous margin. The epipharynx (Epi) lies on the internal surface of the labrum and is covered with fine hairs as far posteriorly as the suture between the clypeus and labrum. Posterior to this suture two sclerotized arms serve as a framework for numerous sclerotized bars which are arched dorsally. These are not shown in the figures.

The mandibles (Figs. 10 and 11) bear on their posterior inner margins a molar area (Mola) covered with transverse ridges which are probably used in the process of chewing food. The anterior ends have one distinct blunt tooth and the tips of the mandibles are modified into a cutting edge. The spines between the mola and the tip are very dense. A membranous area covered with minute setae covers the mola on the dorsal side, the tips of which articulate when the mandibles are closed.

The maxillae (Figs. 12 and 13) are divided into five distinct parts, namely, cardo, stipes, palpifer (Plpfr), galea, and lacinia. The cardo is a rectangular sclerite and bears on its inner margin large condyles which articulate with the head capsule. The stipes is a triangular division anterior to the cardo and contains two sclerites (Crampton, 1923). The palpiger bears on its posterior margin the maxillary palpus which is four segmented, although the first is very small and membranous. The last segment is tipped with tiny granule-like projections which are probably sensory organs. The galea seems to be composed of a single sclerite and is densely covered with brush-like

hairs. The lacinia, attached to the stipes from the dorsal view, bears on its inner surface an area of brush-like hairs and the anterior end terminates in a toothlike structure or blade.

The labium (Figs. 14 and 15) lies on the ventral aspect of the head between the maxillae, and is attached to the head by the mentum and submentum which are usually included as a part of the labium, but strictly speaking are not a part of it (Crampton, 1928). The paraglossae (Pglo) are clearly separated at the anterior margin and are covered with fine setae on the ventral surface. Crampton (1921) calls the true labium the eulabium (which bears the paraglossae, labial stipes and prementum). The central triangular sclerite, the ligula (Lig), is often used synonomously with glossa. It is usually applied to the unpaired median structure projecting between the labial palpi regardless of whether formed by the united glossa alone or whether the paraglossae have entered into its composition (Crampton, 1921). The labial palpi are located on a broad structure known as the palpiger (Plpgr), which is closely joined to the mentum.

The hypopharynx (Hyp, Fig. 16) is a lobe-like structure densely covered with fine hair and supported by heavily sclerotized pharyngeal rods (Phrgl. Rds.) which have small muscle disks on the posterior end. The pharyngeal opening is located at the junction of the hypopharynx and epipharynx.

The submentum (Submtm, Fig. 17) shown in relation to mentum and gula, is attached to the gula by a wide, membranous area. The mentum is oval shaped and is not heavily sclerotized.

THE CERVICAL SCLERITES

The cervical sclerites (Cerv. Scl., Figs. 6, 19, 20) are located on the ventral surface in the membranous area between the head capsule and prothorax. The posterior end of each is broader than the anterior and probable traces of a suture can be found on both posterior and anterior portions. Several small spines project posteriorly from the anterior lateral edge of each sclerite. No attempt has been made to homologize the cervical structures.

THE THORAX

The tergum of the prothorax (Pntm, Figs. 19 and 25) is flattened and nearly twice as broad as long. The pronotum is yellow with the exception of a broad discal black spot. The surface is covered with fine punctures and the lateral margins are thickened and curve slightly upward. A broad emargination at the anterior end overlaps the head while the posterior margin is broadly rounded.

The prosternum (St.–I, Fig. 19) is strongly convex and closely joined to the pronotum which overlaps the suture with a broad margin. No distinct sutures could be found in the prothorax although the outer areas may be pleurites which have become fused with the sternum. These have been labeled Pl–I?. The posterior region of the prosternum bears a median elevation separating the two coxal cavities which are widely open behind. This characteristic of the coxal cavities is one of the distinctions between this genus and *Necrophorus*. The internal view (Fig. 20) shows mainly the muscle attachments (Furca–I).

The mesonotum (Figs. 21 and 22) is occupied largely by the triangular scutellum (Scutel) with which the elytra articulate and under the lateral margins of which they rest, when folded. The praescutum (Praes) is composed of a small phragma which projects downward between the mesothorax and prothorax. The scutum occupies the anterior end of the mesonotum and on either side are two projections which extend anteriorly and downward and are slightly cup-shaped. These probably serve as muscle attachments.

The mesopleuron (Figs. 25, 28 and 29) consists of two sclerites, the episternum (Eps–II), and epimeron (Epm–II) and is figured with the mesosternum and metasternum.

The episternum is roughly rectangular, bearing on its anterior lateral margin the wing processes (Wing Pro.) of the elytron. The inner margin is attached to the mesosternum and the anterior lateral portion to the mesonotum by the axillary sclerites of the mesothoracic wing. There is a small groove at the dorsal junction with the epimeron (Epm–II) in which the anterior lateral edges of the elytra articulate. This can be seen in Fig. 25.

The epimeron is rectangular in shape with the posterior margin broadly rounded. It articulates on its inner margin with the coxa and trochantin of the mesothoracic leg and is separated from the episternum by the pleural suture. It is not connected to the mesonotum at its lateral margin, but loosely covers the metathoracic spiracle (Sp–III), the edge of which can be seen only from the lateral view (Fig. 25). Internally the pleural ridge is very broad and tapers into a pleural arm which is partially fused with a structure similar to the parapterum of the metapleuron. A muscle disk (M. Disk) is located on its inner surface.

The mesosternum (St–II, Figs. 28 and 29), figured with the metasternum and mesopleuron attached, is roughly trapezoidal in shape and the anterior margin serves as an attachment for the intersegmental membranes between the prothorax and mesothorax. The posterior lateral portion extends to the posterior border of the meso-coxal cavities, while the median part joins the metasternum slightly posterior to these. The internal view (Fig. 29) presents a thickened anterior margin to which membranes and muscles are attached. The furcal processes (Furca–II) arising at the posterior margin and anchored to the internal ridge of the metasternum, curve laterally to the pleural ridge of the mesopleuron (Epm–II) and probably serve as an attachment for powerful leg muscles.

The metanotum (Figs. 23 and 24) shows the four typical areas of this division. The praescutum (Praes) is divided from the scutum by the large central membranous area and the two divisions extend laterally almost to the anterior wing processes. These two lateral divisions support the praescutal phragma (A. Ph.) which extends internally towards the center of the body. The scutum is composed of two parts, being divided by the v-shaped ridge separating it from the scutellum. Each half of the scutum is divided into a posterior and anterior region by the internal ridge on the anterior part of the metanotum. The anterior lateral part of the scutum bears the anterior wing processes

(Wing Pros.) with which the first axillary sclerites articulate, and the posterior lateral part the posterior wing processes (Wing Pros.) with which the third axillary sclerite articulates. The axillary cord is attached back of the posterior wing processes.

The postnotum (P. Sctl.) is a long rectangular sclerite lying behind the scutum and scutellum. It is inflexed internally forming the posterior phragma (P. Ph) and serves as an attachment for several muscles and for the membrane which connects the thorax with the abdomen. It articulates with the epimeron (Art. with Epm) at the lateral margins.

The metapleuron (Figs. 25, 26, and 27) is composed of two distinct sclerites. The episternum (Eps–III) is sometimes divided into two regions, the lower division or katepisternum and the anterior division or anepisternum. The posterior division is attached to the metasternum on the inner margin and to the epimeron on the outer edge at the pleural suture (Pl. S.). Its anterior edge is partially fused with the parapterum, on the inner side of which is a large muscle disk (M. Disk) or pronator muscle disk (Snodgrass, 1909). The parapterum and muscle disk border and are closely entwined with the wing processes of the epimeron.

The epimeron (Epm–III) is elongated on its anterior margin to form the wing processes (W. Pro.). Posteriorly it articulates with the postscutellum on its lateral margin and a rectangular extension is bent so that it extends on the dorsal side. This can be seen in Fig. 25. Internally the pleural suture (Pl. S.) becomes the pleural ridge (Pl. Rdg.).

In more generalized insects the epimeron and episternum are arranged crosswise of the body. In the beetles they are apparently shifted so that they are practically parallel with the body walls. The anterior ends are bent so that they form the wing processes (Fig. 25) and the large muscle disk on the internal part suggests that much of the work is done by one large muscle.

The metasternum (St–III, Figs. 28 and 29) is the largest division of the thoracic sterna, occupying the entire area between the hind and middle coxae. It is connected to the episternum at the lateral margins and the posterior part is thickened and serves as an attachment for the abdominal membranes. Internally (Fig. 29) the most conspicuous structure is the large endosternum (End. St.) with the transverse furca (Furca–III) at the anterior end. The median posterior region of the endosternum bears two condyles which articulate with the inner margin of the hind coxae.

The spiracles (Sp–II and Sp–III) of the thorax are shown in Figs. 19 and 25. The mesothoracic spiracles (Sp–II) are located ventrally on the intersegmental membranes between the prothorax and mesothorax and are partially covered by the front coxae. The metathoracic spiracles (Sp–III) are located latero-ventrad near the anterior lateral margin of the mesothoracic epimeron (Epm–II). They are elongate and extend ventrally for over one-half the breadth of the epimeron.

The legs (Figs. 31, 32, and 33) are similar in many respects. The trochantin (Tcn) is found only on the prothoracic and mesothoracic

coxae (Figs. 31 and 32). The prothoracic trochantin possesses a cup-shaped structure on the distal end which articulates with the inflexed area of the pronotum. The front coxae are oblong with very little space between their inner extremities. All the coxae possess a groove into which the femurs fit when folded. The hind femur is longer and broader than the other two and all have a groove on the flexor surfaces into which the tibia fit when folded. The tibia are similar, the hind one being the longest, and all bear several rows of short spurs which project posteriorly. These have not been shown except in the large dorsal view of the whole insect (Fig. 1). All the tarsi are five-jointed and all except the last have brushes underneath and dorsally are covered with numerous hairs not shown in the figures. Two sharply curved claws are present on the last segment.

The metathoracic wings (Fig. 30) are of the Staphylinoidean type of venation, which is distinguished partly by the complete disappearance of the cross veins. The costa (C), subcosta (S), and radius (R) are very close together on the inner basal half of the wing. The median vein is very strong near the tip and has a break midway between the base and distal end, where the wing folds when under the elytron. The cubitals are faint. Two anal veins are present. Possibly the last should be called the third, and the other a fusion of the first and second. No attempt has been made to homologize the axillary sclerites.

The elytra which cover the two thoracic segments and abdomen are brownish with three indistinct costae and numerous cross elevations. They are about as broad conjointly as long and are not fused but open and functional. They articulate with the anterior lateral edge of the mesonotum (Fig. 21) and the wing processes of the episternum (Eps–II, Fig. 29). No attempt has been made to homologize the axillary sclerites which are reduced and very difficult to interpret.

THE ABDOMEN

The tergites (T) of the abdomen (Fig. 3), unlike those of many Coleoptera, are heavily sclerotized with the exception of the first, which is membranous with a distinct longitudinal median line. Eight tergites are visible when the elytra are removed. The second is heavily sclerotized with a wide membranous area separating it from the third. The others when in normal position have no membranous areas exposed, but each overlaps the tergite posterior to it and the fold can be stretched enough to permit freedom of movement of the abdominal segments. The eighth may be invaginated until only the tip is exposed. Two other dorsal sclerites are present and are shown in detail in Figs. 38 and 39 in relation to the genitalia. To homologize these correctly a detailed study of the post-embryonic development should be made similar to the work of Singh Pruthi on *Tenebrio molitor*, 1924. We have labeled these sclerites T–9? and T–10? only as a possible interpretation.

The pleurites are widely separated from the tergites with the exception of the seventh and eighth which are closely joined on the lateral surface.

The sternites (St, Fig. 4) are not separated from the pleurites. The first is membranous except for a small sclerotized area lying under each

hind coxa. All others are heavily sclerotized and covered with small hairs not shown in the figures. Heavy overlapping folds join the sternites in much the same way as the tergites are joined. Two other posterior sclerites are also present which have been designated St–9?.

The spiracles (Sp) of the abdomen (Fig. 3) are eight in number, the first being the largest. It is elongate and broader on its inner margin which is partially covered with an overlapping fold of membrane. The second, third, fourth, and fifth spiracles are located in the membranes near the inner dorsal margins of the pleurites. The sixth, seventh, and eighth are located on small sclerotized areas on the tergites and although very small are still functional.

THE MALE GENITALIA

The terminology of Sharp and Muir (1912) is followed in interpreting the male genitalia. These are probably more concerned with internal anatomy but since they are so heavily sclerotized they have been considered as falling in the scope of this study.

The male genitalia (Figs. 38, 39, 40, 41, 42, and 43) are composed of three main sclerotized divisions, namely, the lateral lobes (Lat. Lobes), the median lobe (Med. Lobe), and the basal piece (BP).

The median lobe, which is practically cylindrical and sclerotized on the ventral surface but membranous on the dorsal side, encloses the ejaculatory duct (Ej. Duct), which may be extruded from the median orifice (Med. Or.) located on the dorsal tip. The lateral lobes, situated on either side of the median lobe, are sclerotized on their outer lateral margins and membranous interiorly next to the median lobe. The elongate basal piece is a heavily sclerotized rim with internal membrane. The anterior portion viewed laterally (Fig. 43) is thicker than the posterior part. Ventral to the basal piece there is a y-shaped supporting structure, the spiculum (Spi, Figs. 38, 39, 40), which probably aids in the movement of the genitalia. It is cup-shaped at the anterior end and fits over the basal piece while the posterior ends are attached in the membranous area anterior to the sclerite labeled St–9?.

The ejaculatory duct (Ej. Duct) enters the median lobe ventral to the basal piece and ends at the median orifice (Med. Or.). The internal sac (Int. Sac) is very prominent and projects anteriorly over the edge of the basal piece. A thin membrane which is attached at the base of the lateral lobes forms the genital pocket (Singh Pruthi, 1924). The anus is dorsal to the genital opening and is shown in Fig. 38 only by dots as it lies under the dorsal plate marked T–10?.

THE FEMALE GENITALIA

The female genitalia are shown in Figs. 44–48. In view of the fact that our data is furnished by the sclerotized parts only, we have used the terms applied by Tanner (Genitalia of Female Coleoptera, 1927). In using these we do not argue that they are the correct interpretations of homologies. The homologies of genital parts of beetles will not be known until work of a different type has been done. Apparently three lines of study will eventually solve the problem of the homologies of these parts, namely, (1) studies such as that of Tanner on the com-

parative anatomy of the sclerotized parts of beetles, of Walker on Orthopteroid insects, and of Crampton on insects in general; (2) studies on post-embryology such as made by Muir and Singh Pruthi, and (3) studies of the musculature of parts as made by Snodgrass, Weber and Norma Ford. Thus we are not positive of the parts labeled paraprocts, proctiger, and valvifer, but use these parts only as labels. The anus is dorsal to the genital opening.

SECONDARY SEX CHARACTERS

In size there is no constant noticeable difference between male and female. However, the angle at the tip of the elytron of the female (Fig. 35) is much more acute than in the male (Fig. 34). The front tarsi of the male (Fig. 36) are dilated much more decidedly than those of the female (Fig. 37). No differences could be found in the antennae.

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EXPLANATION OF PLATES

Plate I

Fig. 1. Dorsal view of *Silpha americana.*
Fig. 2. Ventral view of *Silpha americana.*
Fig. 3. Dorsal view of abdomen.
Fig. 4. Ventral view of abdomen.
Fig. 5. Dorsal view of head capsule.
Fig. 6. Ventral view of head capsule.
Fig. 7. Endoskeleton of head capsule.

Plate II

Fig. 8. Internal view of labrum showing epipharynx.
Fig. 9. External view of labrum with clypeus removed, showing internal sclerotized rods.
Fig. 10. Dorsal view of left mandible.
Fig. 11. Ventral view of left mandible.
Fig. 12. Dorsal view of left maxillary.
Fig. 13. Ventral view of left maxillary.
Fig. 14. External view of labium.
Fig. 15. External view of labium, mentum and submentum removed, showing pharyngeal rods.
Fig. 16. Internal view of labium showing hypopharynx.
Fig. 17. External view of mentum, submentum, and gula.
Fig. 18. Antenna.

Plate III

Fig. 19. External view of prothorax.
Fig. 20. Internal view of prothorax.
Fig. 21. External view of mesonotum with elytron attached.
Fig. 22. Internal view of mesonotum.
Fig. 23. External view of metanotum.
Fig. 24. Internal view of metanotum.
Fig. 25. Lateral view of thorax.
Fig. 26. External view of metapleuron.
Fig. 27. Internal view of metapleuron.

Plate IV

Fig. 28. External view of mesosternum and metasternum with mesopleuron attached.
Fig. 29. Internal view of mesosternum and metasternum with mesopleuron attached.
Fig. 30. Metathoracic wing.
Fig. 31. Prothoracic leg.
Fig. 32. Mesothoracic leg.
Fig. 33. Metathoracic leg.
Fig. 34. Tip of male elytron.
Fig. 35. Tip of female elytron.
Fig. 36. Front tarsus of male.
Fig. 37. Front tarsus of female.

Plate V

Fig. 38. Dorsal view of male genital segments with genitalia in place.
Fig. 39. Ventral view of male genital segments with genitalia in position.
Fig. 40. Lateral view of male genital segments.
Fig. 41. Dorsal view of male genitalia.
Fig. 42. Ventral view of male genitalia.
Fig. 43. Lateral view of male genitalia.
Fig. 44. Dorsal view of female genital segments.
Fig. 45. Ventral view of female genitalia.
Fig. 46. Dorsal view of coxite and stylus, (valvifer removed from right hand figure).
Fig. 47. Ventral view of coxite and stylus, (valvifer removed from left hand figure).
Fig. 48. Lateral view of female genital segments.

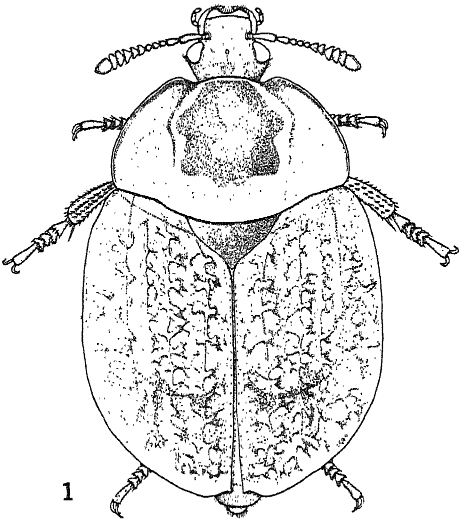
ABBREVIATIONS USED ON FIGURES

A, anal vein.
A. Ph., anterior phragma.
Ant. Arm, anterior arm of the tentorium.
Art. with Epm., articulation with the epimeron.
Ax. C., axillary cord.
BP, basal piece.
C, costa.
Cerv. Scl., cervical sclerites.
Clyp, clypeus.
Co, coxite.
Cu, cubitus.
Cx, coxa.
Dor. Arm, dorsal arm of the tentorium.
Ej. Duct, ejaculatory duct.
End. St., endosternum.
Epi, epipharynx.
Epm, epimeron.
Eps, episternum.
Gen. Op., genital opening.
Hyp, hypopharynx.
Int. Sac, internal sac.
Lat. Lobes, lateral lobes.
Lbr, labrum.
Lig, ligula.
M, median veins.
M. Disk, muscle disk.
Med. Lobe, median lobe.
Med. Or., median orifice.
Mtm, mentum.
Par, parapterum.
Pglo, paraglossa.
Phrgl. Rods, pharyngeal rods.
Pl, pleurite.
Pl. Rdg., pleural ridge.
Pl. S., pleural suture.
Plpfr, palpifer.
Plpgr, palpiger.
Pntm, pronotum.
Post. Arm, posterior arm of the tentorium.
Ppr, paraproct.
P. Ph., posterior phragma.
Praes, praescutum.
Proct, proctiger.
P. Sctl., postscutellum.
R, radius.
Sc, subcosta.
Scutel, scutellum.
Sp, spiracle.
Spi, spiculum.
St, sternite.
Sty, stylus.
Submtm, submentum.
T, tergite.
Tcn, trochantin.
Vf, valvifer.
Wing Pro., wing process of meso- and metapleuron.
Wing Pros., anterior and posterior notal wing processes.

NUMBERING

Roman numerals I, II, and III, refer to the prothorax, mesothorax, and metathorax respectively. Numerals 1–10 designate first to tenth abdominal segments.

PLATE I



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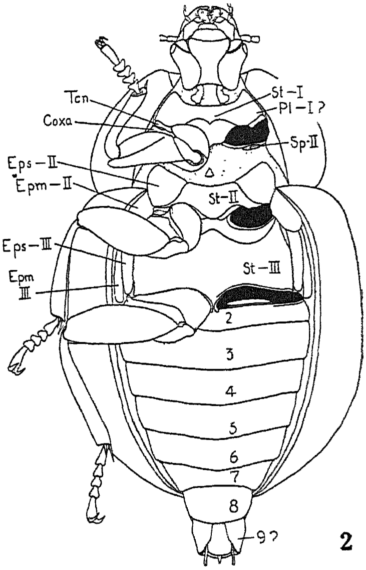

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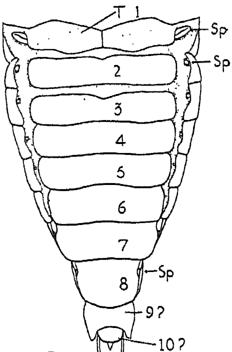

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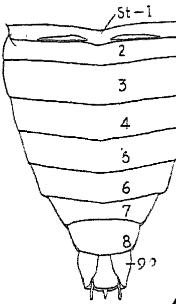

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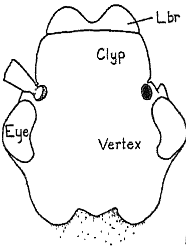

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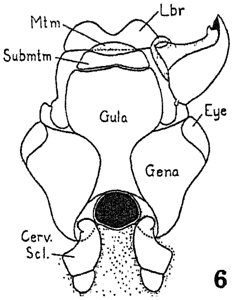

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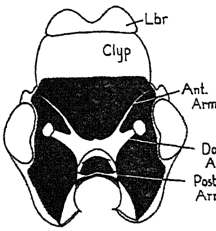

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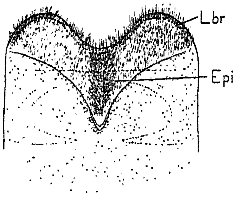
Silpha americana
Norris D. Blackburn

PLATE II



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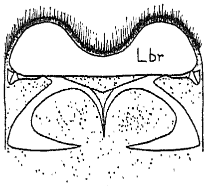

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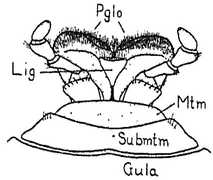

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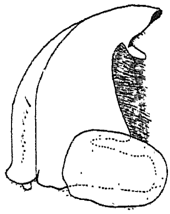

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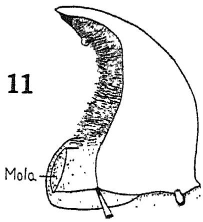

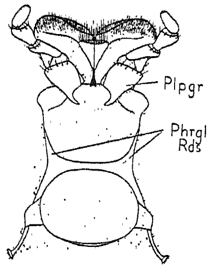

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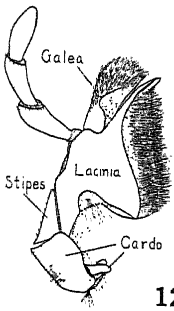

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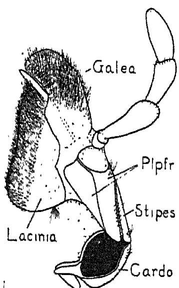

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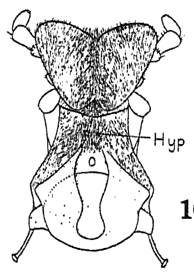

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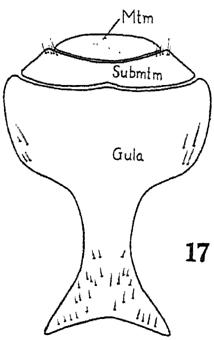

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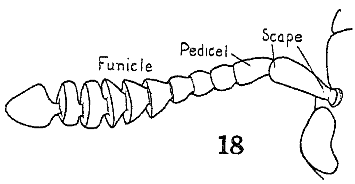

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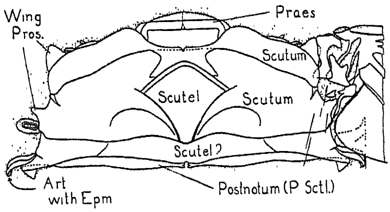

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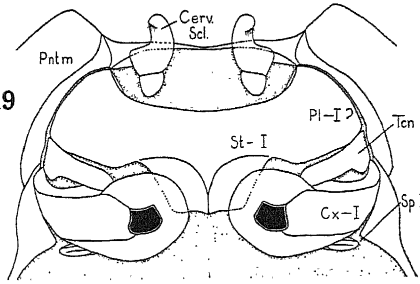

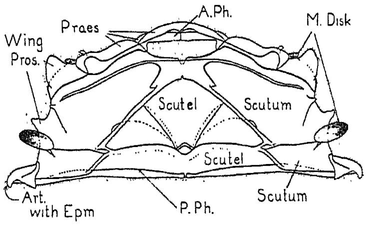

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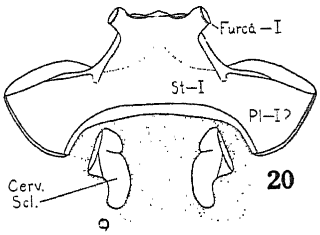

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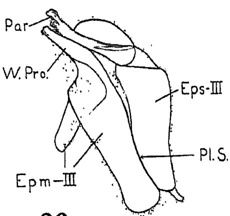

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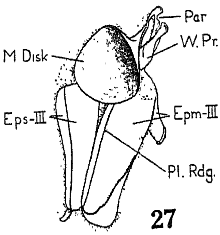

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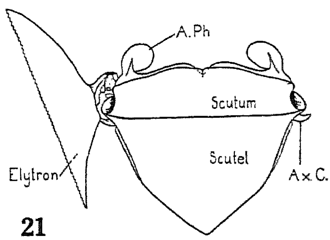

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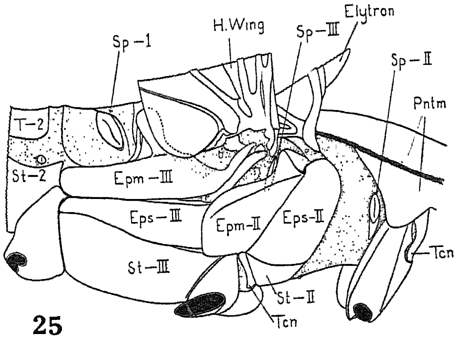

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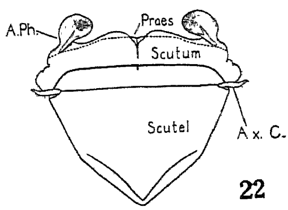

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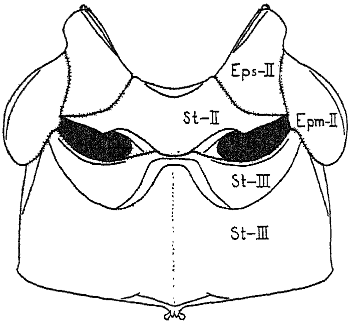

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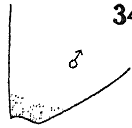

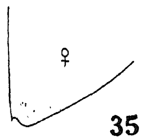

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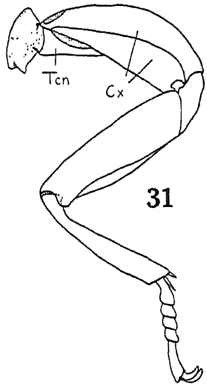

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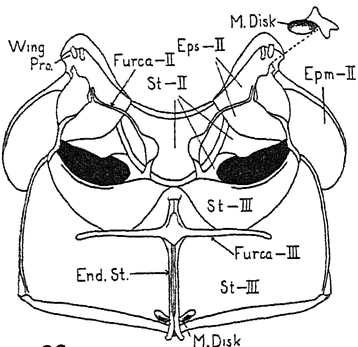

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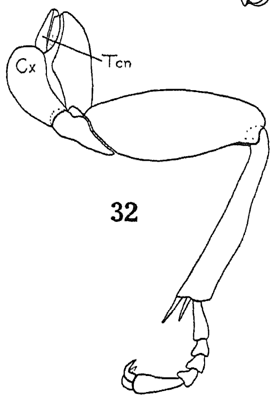

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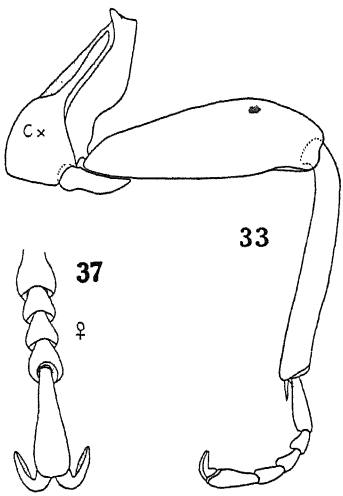

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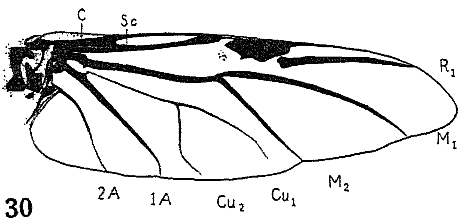

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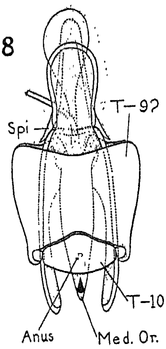

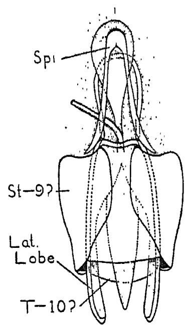

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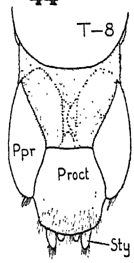

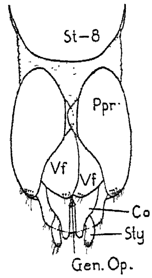

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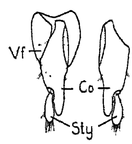

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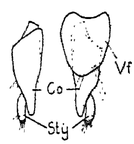

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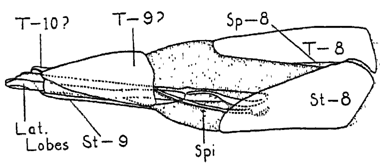

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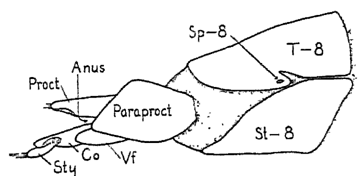

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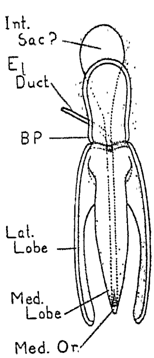

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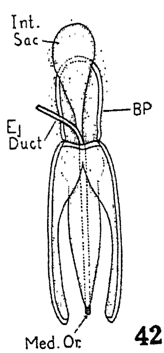

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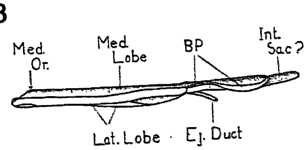

BOOK NOTICES

Cells and Tissues

A clear, forceful style, terse, pithy sentences, and short, compact chapters characterize this excellent introduction to histology. While valuable to the medical student, the applications of the book do not end there. The author has kept in mind the interrelations of a knowledge of cells, tissues, endocrine glands and other organs with the broader aspects of genetics, evolution, physiology and the social sciences. Each tissue, organ and system is thoroughly though briefly discussed. Especially good are the chapters on blood, marrow, and the endrocine glands. As here presented, the subject matter of histology becomes an integral and essential part of biological knowledge and culture. Students of biology in any of its phases will enjoy and profit by this volume.—L. H. S.

A Textbook of Histology, by Joseph Krafka, Jr. vii+246 pp. Baltimore, The Williams and Wilkins Co., 1936. $2.50.

The Great Naturalists

This is a series of historical essays, delightfully written and attractively printed and bound. From the classic scholars of Greece and Rome to the modern observers and students of nature, the great naturalists of history pass before us. We catch intimate glimpses of their work and their inspiration, their hopes and fears, their failures and successes, and above all, their love of nature and the living world. We find ourselves inexorably caught in the spirit of the book, and born buoyantly on the current of outdoor investigations. From Aristotle through Baubin, Gesner and Rondelet, Malpighi, Swammerdam and Leauwenhock, Buffon and Reaumur, Linnaeus and Artedi, Cuvier and Lamark, Bartram and Michaux, Wilson and Audubon, Say and Rafinesque, Goethe and the Romanticists, Darwin and Wallace to Fabre, the spirit of research in natural history permeates and gives life to the book. For those who know the peace and the turbulence, the satisfaction and the despair of research in the field, the volume is highly recommended. For those who have not this knowledge, a reading of this book is not only recommended, but strongly urged.—L. H. S.

Green Laurels, by Donald Culross Peattie. xxiii+368 pp. New York, Simon and Schuster, 1936. $3.75.

Biometry

"An Outline of Biometric Analysis," by Alan E. Treloar, in its 1936, second edition, covers the fundamentals of statistical procedure in a practical and progressive manner. Of special importance is the clarity of the text, wherein lies its appeal to the non-mathematical research worker or student.

The outline is divided into three parts, each of which is designed to form the basis of a term of college work, or the whole when supplemented with practical or laboratory problems should form a sequence for progressive work for the school year. The first part introduces statistical measurements in univariate and bivariate frequencies, some uses of the chi square test, and the significance of differences in means. The second part deals with the correlation ratio, contingency, partial correlation and intra-class correlation. The third part elaborates the techniques of the "small sample" and the elements of "analysis of variance."

In this outline we have a sound contribution to a field that has too long remained obscure, not because of innate difficulty, but rather for lack of clear presentation of fundamentals. The research worker or student wishing to develop confidence in statistical usages will find this outline a valuable aid, for the algebraic derivations necessary for routine applications are carefully worked out, and interpretation of results in terms of probability is stressed in each section of the outline.—R. G. SCHOTT.

An Outline of Biometric Analysis, by Alan E. Treloar. 193 pp., mimeoprint. Minneapolis, Burgess Publishing Co., 1936. $3.10.

The Psychology of Education

Twenty-five psychologists and educators from twenty-two colleges and universities have collaborated to produce this volume. Although each chapter is by a different author, the continuity is excellent and the arrangement logical and functional. Among the topics treated are growth, acquisition of skills and knowledge, attitudes, problem solving, creative activity, motivation, character and personality, learning, individual differences, nature and measurement of intelligence, educational measurements, teacher evaluation and guidance. The genetic viewpoint is clearly kept in mind, and the co-operative role of genetic and environmental influences in the production of characteristics is recognized and stressed throughout the book. It is indeed a pleasure to find the biological basis of behavior so clearly perceived and used in the treatment of a subject which all too often lacks the biological approach.—L. H. S.

Educational Psychology, by twenty-five collaborators, edited by C. E. Skinner. xxvi+754 pp. New York, Prentice-Hall, Inc., 1936. $3.20.

Radiation

The development of the quantum mechanics which has made it possible to make quantitative theoretical predictions concerning atomic and molecular phenomena has had its most evident successes in the application to actual atomic and molecular mechanical problems rather than in theory of radiation. This field which deals not only with such items as, for example, the shapes and breadths of spectral lines, dispersion, etc., but also is fundamental in the study of cosmic rays and other nuclear phenomena, is one of ever increasing importance in modern physics. It is therefore with enthusiasm that we receive this book, The Quantum Theory of Radiation, the first of its kind to systematically present an account of this theory. Beginning with a discussion of the classical theory of radiation, such subjects as field theory, the interaction of radiation with matter, radiation processes connected with the positive electron and the penetrating power of high energy radiation is discussed in the quantum theory. This work can be heartily recommended as one which deserves a place among the other books on the physicist's shelf.—H. H. NIELSON.

The Quantum Theory of Radiation, by W. Heitler. xi+252 pp. Oxford, at the Clarendon Press, 1936. $6.00.

How to Know the Insects

This book was prepared by the author with special reference to the insects of Iowa, but should have a rather wide application because many of the species found in Iowa are also common throughout the Mid-west. The material presented by the author is as follows: the place of insects in the world; the development of insects; directions for collecting and mounting insects, including a list of 65 places to look for insects; how to use an identification key; an illustrated key for the identification of the more common families of insects; the Iowa insect survey; a list of the Orders and Families of insects with a common example for each family and a note on where they can be found; and a combined index and glossary of important terms.

Under the topic of collecting and mounting the author gives types of nets, ways of making nets, making killing bottles, use of baits, traps, and the making of light traps. Methods of pinning, spreading, various types of mounts, and the labelling of insects are discussed rather thoroughly. The illustrated key has one common representative of each family figured and briefly described. This should be valuable especially to a beginner in entomology.

The book is planographed by the John S. Swift Company and may be obtained with either side staple binding or spiral binding. The book should be useful to the high school biology teacher as well as to college students who are being exposed to their first taxonomic studies in entomology.—R. H. DAVIDSON.

How to Know the Insects, by H. E. Jaques. 140 pages, 251 figures. St. Louis, The John S. Swift Co., Inc., 1936. $1.00. (Twenty-five per cent discount on orders of 10 copies or more. The book may also be obtained from the author at 709 N. Main Street, Mt. Pleasant, Iowa.)

Biology

This book is a general introduction to biology. It should prove particularly useful to that group of students who do not continue in either botany or zoology. The major portion of the book consists of a study of the physiological processes of selected type forms, both plant and animal. No attempt is made at completeness from the standpoint either of systematic zoology and botany or of biological theories. There is very little said concerning ecology, parasitology or economic importance. Emphasis is placed upon unity of life processes. What is an animal, and how does it live? What is a plant, and how does it live? How do animals and plants differ? These three questions are discussed in this book. The section on heredity is clear and understandable, presenting the basic principles of this phase of biology. Dr. Rice's discussion of evolution is especially well organized and leads one gently but firmly to a rational conclusion. The book is well illustrated, the type large and clear, paper and binding are of good quality.—J. A. MILLER.

An Introduction to Biology, by Edward Loranus Rice. xii+602 pp. Boston, Ginn and Company, 1935.

Biological Effects of Radiation

Biologists and physicists alike have prospected the ever-broadening field which links their sciences with results which have often been no contribution to either. This two volume work, sponsored by the National Research Council, should aid in bridging this gap, and help investigators to tread more securely as they approach many of the problems of biophysics. Forty-six authors have collaborated in the preparation of the forty-three papers which are included. Each of the authors is a well known investigator in the field concerning which he has written. The editor-in-chief has guided the compilation of this material with the assistance of six collaborating editors.

Papers I–V, inclusive, and VII deal with the fundamental aspects of radiant energy phenomena and should prove of interest to all biologists. They are readily comprehensible to any reader with an elementary knowledge of physics and admirably epitomize the present status of physical knowledge and theory in the field of radiations. The papers on "Photons and electrons" (Darrow) and "Measurement and application of visible and near-visible radiation" (Brackett) especially should attract widespread attention.

Each of the remaining thirty-six papers deals with a specialized phase of the effects of radiant energy upon living organisms. Few aspects of the subject have escaped consideration. Not all of these contributions will be of interest to any one biologist, but every biologist should find at least a few of them to more than repay him for the time required for their reading. Plant science is better represented than animal science, twenty of the papers dealing primarily with influences of radiation upon plants. This distribution of the topics discussed reflects primarily the greater attention which botanists have devoted to radiant energy effects than zoologists.

Without prejudice to the other contributions, all of which appear to be meritorious, the following may be mentioned as most likely to be of interest to biologists generally: "Radiation and the vitamins" (Bills), "Motor responses to light in the invertebrate animals" (Mast), "Action of radiations on living protoplasm" (Heilbrunn and Mazia), "Photoperiodism" (Garner), "Light Factor in photosynthesis" (Spoehr and Smith), "Effects of radiation on bacteria" (Duggar), and the series of five papers by Dobzhansky, Schultz, Stadler, Goodspeed, and Anderson upon chromosomal aberrations and mutations as induced by radiations. The dispassionate review by Hollaender of the status of the problem of mitogenetic rays is a welcome contribution to this highly controversial subject.

Most of the papers are copiously and excellently illustrated, many of the fundamental relations being graphically presented. Practically every paper includes a selected bibliography, many of which are extensive. The value of these is self-evident. It is a book to which any alert biologist will be able to turn again and again with profit.—B. S. MEYER.

Biological Effects of Radiation. Edited by B. M. Duggar. Two vol., 1,342 pp. New York, The McGraw-Hill Book Co., 1936.

Mining

The subject of mine economics has been little touched upon by the mine engineer and geologist and hence it is with pleasure that this book comes to hand. It is divided into three parts: Mine Valuation, Mine Organization, and Mine Management. Under Mine Valuation, Prof. Hoover goes into great detail as to how to correctly evaluate a mine from the sampling to the final report. All persons having to make either engineering or geologic reports should read this chapter on "reporting." In the section on mine organization are considered the set-up of mining companies, promotion, the stock exchange and a series of interesting descriptions of things to beware of under the heading "Fakes and Fallacies." Many good warnings often unheeded by the investing public are included here. An all-too-brief but with-all very good chapter on the Mining Engineer and the Law finishes Part II. In Part III (Mine Management) we are concerned with the organization and duties of the mine staff from the manager down. This section also considers the training and discipline of mine personnel, and their safety, health, and welfare. The last chapter discusses the young engineer and his career. Here is much good advice for the young graduate.

This is a most valuable book and although directed primarily at mine engineering, it would also apply to petroleum engineering and other phases of economic geology. It can be recommended for all students of geology even though they do not expect to be engineers. Most if not all geologists at one time or another are connected with economic problems and would find this volume very valuable. Investors in the mining industry would also find it of value as would some boards of directors and others having to do with the employing of geologists. Much misunderstanding might be avoided if the facts included in this volume were more commonly known. The book is well organized and well written. Rather complete bibliographies with each chapter are very useful as is the carefully worked out and complete index.—WILLARD BERRY.

The Economics of Mining (Non-ferrous Metals), by T. J. Hoover. viii+547 pages. Stanford University Press, 1933. $6.00.

Elementary Geology

There is now available a book of some 500 pages divided into fifty-one chapters which covers in an interesting and non-technical manner the field of general geology. The first thirty chapters cover what is usually termed physical geology and the last twenty cover historical geology. Numerous figures, some more or less humerous but in general to the point, are scattered through the text. Some of them we fear are somewhat too jocular and are likely to instill the wrong impression in the student's mind. We refer to the cephalopoda with arms and legs, using dumbbells and other such pictures. There are in addition to text figures 64 pages of rotogravure pictures in four groups. These illustrations are excellent and as far as we know a new step in geologic texts. It is to be regretted that the titles of the pictures do not clearly indicate the scenes to which they refer. Another criticism is that pictures on widely different scales are shown on the same page with no reference to the exact size. For example, on Plate 61 a picture entitled "Large fishtail drills" shows in part several fish tail drills and just below is a "Gusher in a Crane Field." The largest "fishtail" is three inches high and the "gusher" only about two inches. Some scale should have been introduced. This is one of the University of Chicago "New Plan" texts and as such is to be used in the geological program for the physical science general course. As part of a general course in physical science it may serve satisfactorily. For a full term college course it would appear to be entirely too elementary and rather difficult to teach. The arrangement seems awkward and although we do not ask for any set order the one followed here does not seem to intergrate with any laboratory set-up. After all, geology is a laboratory science. Although we would not care to use it as a text we have had students who would have benefited by reading it.

The make-up is excellent. It is printed in clear type on non-calendared paper, making for easy reading. The use of rotogravure pictures gives excellent reproduction.—WILLARD BERRY.

Down to Earth, by Croneis and Krumbein. xviii+501 pages. Chicago, University of Chicago Press, 1936.

Structural Geology

During the past five years there has been quite an advance in structural geology. Nevin in the second edition of his text on structural geology follows the same method of treatment as in the former edition. The text is divided into twelve chapters; it begins with the physical properties of rocks and ends with mountain systems. A chapter on "Structures associated with Igneous Intrusions" is by E. B. Mayo and is an addition to this edition. Various phases of structural geology are taken up from several different viewpoints. This is especially true of the more disputed parts of the field. The chapter on "Some Facts, Inferences and Hypotheses Regarding the Earth— gives an excellent picture of what we know and what we infer. The discussion of isostasy and continental drift is well handled. It is presented so as to present the several sides of the arguments, allowing the student to realize that all is not finished. The references, although primarily from American sources, are such that the more advanced students will find leads into the detailed literature. The discussions are in general simple and clear. Some of the terms used such as high-angle and low-angle faults, seem to us to be poor usage. The use of foot-notes and of numbered references as well is confusing.

This text should prove even more popular than the first edition. It is well written and quite readable. The illustrations are good. It is a beginning text and makes no pretense to be otherwise. Needless to say the make-up and typography are in the usual style of the publishers.—WILLARD BERRY.

Principles of Structural Geology, by C. M. Nevin. xii+348 pp. New York, John Wiley and Sons, 1936.

Mineralogy

For those familiar with the second edition of this work we need only quote from the Preface of the third edition: "Changes have been made in the chapters of Physical Properties, the Polarizing Microscope, Crystal Structure and X-ray Analysis, and the Formation and Occurrence of Minerals. . . . Sixty-six illustrations have been added, and the number of pages has been increased by thirty-four." For those not familiar with this text we find it divided into 18 chapters: crystallography, the six crystal systems, compound crystals, physical properties, the polarizing microscope, crystal structure and X-ray, chemical properties, formation and occurrence of minerals, qualitative blow-pipe methods, descriptive mineralogy, gems and precious stones, and classification of minerals according to elements. This takes up 438 pages. A glossary of 222 terms comprises 6 pages. A tabular classification showing elements of symmetry and the simple forms of the 32 classes of crystals takes 7 pages. The rest of the text is devoted to tables for the determination of the 150 minerals described. These tables are based first upon the color and luster of the mineral, then upon the streak, finally upon increasing hardness. When these are run down the other physical properties are used to completely identify the mineral. Brief descriptions of the minerals are given in the tables. A rather full index completes the book.

This is definitely a text for introductory mineralogy of college level, and as such it is excellent. We question the advisability of including so much on X-ray analysis in a text of this rank. The illustrations of the minerals and crystals are excellent and clear. The inclusion of pictures of important mineralogists has our hearty approval. Such pictures add much to the interest of the beginner and help all of us to remember how some of our friends looked. A few of the rock-type figures do not give clear ideas of the rock texture. We refer especially to figures 4 and 5; either figure might be titled the opposite of what it is. However, we will admit that it is nearly impossible to take pictures of marble and sandstone of about the same grain size and reduce the picture and still show any great difference. This text is very well suited for general introductory mineralogy where the number of minerals to be studied is within the 150 described. The make-up and handling are in the usual excellent style of the publishers.—WILLARD BERRY.

Mineralogy, An Introduction to the Study of Minerals and Crystals, by E. H. Kraus, W. F. Hunt, and L. S. Ramsdell. Third edition, x+638 pp. New York, The McGraw-Hill Book Co., 1936.

One Man's Idea of Physical Science

Sir Arthur Eddington believes that the world of physical science with all its apparent complexity is not so strange as the human mind which has assigned to it this complexity. The world picture is, in short, the result of the reaction of man's consciousness with it, rather than a picture having an inherent truth apart from that consciousness. Eddington has already had a good deal to say concerning this viewpoint in "The Nature of the Physical World" and "The Expanding Universe." In the present book, "New Pathways in Science," he adequately discusses contemporary developments in physical science again from the same point of view. Many who are convinced that real electrons swoop dizzily around real nuclei in real orbits will probably not agree with Sir Arthur, but in the opinion of the reviewer his is much the soundest way of looking at the problems of physical science.

"New Pathways in Science" integrates current ideas in physics, astronomy and philosophy. There are chapters on the Decline of Determinism, Indeterminacy (one of the very few adequate treatments that has yet been written on this subject), Probability, Constitution of the Stars, Subatomic Energy, Expanding Universe, and the Theory of Groups. All these are written in Eddington's engaging but minutely penetrating style.

The book is one that should be read by everyone having a mature interest in physical science whether they agree with this one man's idea of the universe or not.—C. HESTHAL.

New Pathways in Science, by Sir Arthur Eddington. x+333 pp. New York, The Macmillan Co., 1936.

Statistical Methods

In this revised edition we have almost a new book. Symbols and formulae are brought into standard form, and new and specialized techniques are given a place. Perhaps most important is the assemblage of tables useful in statistical calculations and determination of significance. Among the tables, besides those given as computation aids, squares, cubes, etc., are values of the probability integral, a table of odds, ordinates of the normal curve, Chi square, tables of F for ratio of variances, t for significance of mean differences, and significance and values for r in several combinations and functions. Tables for use in the study of human inheritance give values of Q for various sized families and various cross-over values, and the standard error of Q (Wiener). Tabulated proportions of expected recessives in random matings of dominants, R and S classes, (Snyder), are also included. The book fulfills its conception as a manual for the worker confronted with the need for reference forms, however it is by no means exhaustive in the applications of any particular technique. The exposition is crisp and concise and each method of procedure is illustrated with problem material so that a novice in statistics should be able to follow the technique. The student of statistics will notice the lack of algebraic derivation that give formulae relationships. But as a manual for definition of working forms one is gratified to find so much practical and fundamental material assembled in a small convenient volume.

—R. G. SCHOTT.

Statistical Methods in Biology, Medicine and Psychology (4th Edition), by C. B. Davenport and Merile P. Ekas. xii+216 pp. New York, John Wiley and Sons, Inc., 1936.

How Animals Develop

To understand how animals develop is to know what they are. Our present knowledge, however, is a polychrome mosaic, black in many places, but being filled in with blocks from many sources. The beginning student of embryology finds himself hopelessly confused in the task of tracing both the pathway of development, from ovum to adult, and the interplay of forces which determine it. Numerous descriptive studies trace in detail development as observed from sections and reconstructions. But what of the rapidly growing literature dealing with micromanipulations and analyses, with artificial parthenogenesis, the role of vitamins and hormones, the function of the newly-discovered organizers, and the interaction of genes and cytoplasm? What is the significance of mutilation experi-

ments, of transplantations, of vital staining and tissue culture? Where do axial gradients come in, and do we still retain Haeckel's law of Recapitulation?

A simple, clear statement is indeed needed and welcome. Professor Waddington has attempted to give just such an exposition. He has brought these questions together and shown their interrelationships in a way not otherwise understood by the student without a very wide range of reading and thought. Writing in relatively simple but precise language, the author, I think, will make himself clearly understandable to the beginning student in embryology, and stimulate him to read further. Many questions are raised; a few are answered.

This volume does not constitute a source book in any sense. Its main usefulness is probably in orienting and stimulating the student. The author's hope of writing intelligibly for the interested layman is doubtfully realized. However, the difficulty lies more in the inherent complexity of the subject and the prerequisite of a broad reading knowledge in Biology.—John W. Price.

How Animals Develop, by C. H. Waddington. 128 pp. New York, W. W. Norton & Co., 1936.

Physical Chemistry

This new work departs rather widely from the traditional formula for a physical chemistry textbook. The author places great emphasis upon the state of equilibrium in a chemical reaction and the rate at which the equilibrium is attained. The book is written around these two fundamental chemical problems. Consequently the arrangement of material differs from that of most other works in the field. There are no single chapters on the liquid state or the solid state, material on these states being distributed through the book under the various general headings. Certain fundamental propositions are discussed at length, such as the laws of thermodynamics and the theory of Debye and Huckel. Some subjects usually included in elementary texts are omitted; there is no discussion of the colloidal state.

The treatment is unusually mathematical for a beginners' textbook, and is designed for students with a knowledge of calculus. Detailed explanations usually accompany and clarify the calculations. The excellent chapter on the quantum theory is for the mathematically inclined reader only.—Herman Von Dach.

Elementary Principles in Physical Chemistry, with special reference to the state of equilibrium in a chemical reaction and to the rate of attainment of the state of equilibrium; by T. J. Webb. x+344 pp. New York, D. Appleton-Century Company, 1936.

Earthquakes

Earthquakes—such a title brings to mind the scare heads of the newspapers telling of the damage, the loss of life, and so on accompanying the scattered major earthquakes, but usually does not bring to mind the detailed and careful studies carried on by students of earthquakes and of the earth's interior. Dr. Heck has put into some 218 pages a rather exact account of the what and the way, as far as known, of earthquakes. In a relatively non-technical manner he has given us a general review of some of the progress of seismology. The first nine chapters deal with the effects, causes and studies of earthquakes coupled with their recording and interpretation. The seismic belts of the earth are discussed in chapter ten, while the next chapter discusses some seventeen of the world's great earthquakes. The earthquake regions of the United States are handled in chapter eleven and the next two chapters consider regional investigations. The human side with safe construction is not forgotten. An answered questionnaire of some 23 factorial questions makes up chapter sixteen. A brief history of Seismology closes this very useful book.

The book is written in a non-technical style, and although somewhat meaty is nevertheless good reading. The numerous pictures, diagrams, and charts are well selected and add much to the text. We feel that Dr. Heck has given us a book which should fill an important place as a general reference for students in geology and related fields. It is not a text, but a general book.—Willard Berry.

Earthquakes, by Nicholas Hunter Heck. xi+222 pp., Princeton University Press, 1936. $3.50.

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THE THEORY OF LAKES AND MOUNTAIN BARRIERS IN EARLY AMERICAN GEOLOGY

A. S. FURCRON

Between 1750 and 1820, views upon American physiography were embraced in a conception of mountain barriers holding back an enormous lake which occupied the central part of the United States. The great barrier which held back this lake was the Blue Ridge. It was thought that modern Appalachian topography was formed when this lake broke through the barrier and drained the area now occupied by the central states.

The theory probably arose at Philadelphia and gained widespread popularity in the scientific world of the day, especially through the writings of Jefferson and Volney. It was the first attempt of American and European scientists to explain the physiography of the eastern United States, and was based upon the belief that mountains were formed before rivers and lakes, a belief which survived until 1880. The theory presented a strong appeal to active imagination. It is still encountered locally in the east where it is used to explain the origin of gaps in the Blue Ridge.

The early seventy years of American geology (1750–1820) were necessarily a period of speculation. There were no accurate maps to show the positions of the Appalachian mountains and Blue Ridge, and little was known of their elevation. Thomas Jefferson determined the elevation of some of the peaks and gaps in the Blue Ridge of Virginia, yet he thought that the Peaks of Otter were the highest mountains in the United States. The geologists, Maclure and Volney, pursued their studies on foot. Travel in general was by coach, which afforded little opportunity for the study of natural features. Many basic principles in geology were not developed at this period, and many who wrote upon geology had no particular training in that field.

Thomas Hutchins (1730–1789), the first American topographer, outlined the physical features of the eastern colonies in 1778. On his map the Appalachian ridges extend as far west as Fort Pitt. and swing southwestward in a great arc from Pennsylvania to Muscle Shoals (sic) near Mississippi River.

It is probable that the conception of a great inland lake held in by an eastern mountain barrier first spread from Philadelphia, which was then the intellectual center of middle-eastern United States. The first reference to this theory known to the writer, is found in the travels of Peter Kalm[1] who, while in America (1748–1751), spent some time near Philadelphia with the botanist Bartram.

Mr. Bartram was a remarkable observer for the times. Kalm asked him "Whether he had observed in his travels that the water was fallen, and that the sea had formerly covered many places which were now land." Bartram answered that from his experience he was convinced that the greatest part of the country had formerly been under water. He listed many reasons for this belief. (1) Oyster shells occur in the Blue Mountains and its valleys, three hundred miles from the sea. They are found loose and also in the rock. (2) They are dug up in Virginia, Maryland, New York and Philadelphia. Trees, roots and oak leaves are encountered by well diggers at Philadelphia and other places. (3) Valleys bounded by mountain ridges in this country once were covered by lakes. The water finally broke through the mountains and released the lakes. "Such vallies and cloven mountains are very frequent in the country, and of this kind is the peculiar gap between two mountains, through which a river takes its course, on the boundaries of New York and Pennsylvania. The people, in a jest, say, that the opening was made by the devil, as he wanted to go out of Pennsylvania into New York." (4) "When savages are told that shells are found on these high mountains, and that from thence there is reason to believe that the sea must formerly have extended to them, and even in part flown over them, they answer, that this is not new to them, they having a tradition from their ancestors among them, that the sea formerly surrounded these mountains."

Bartram seems to have believed that the mountain barriers were broken and lakes released at the time of the Deluge.

[1]Peter Kalm, "Kalm's Travels in North America," translated by J. R. Forster, London (1772), 2nd ed.

Later observers make little mention of the Deluge, but thought that the breaks in the mountains were made by natural rather than supernatural processes. Thomas Twining, who later helped to lay the foundation of the Indian Empire, said that it was common belief among American geologists that the "Blue Mountains were once the boundaries of an immense lake till the Susquehannah, Potomac, and other rivers burst through them."[2]

Smyth in 1784, writing of the eastern central states, mentions "the mountains suddenly broken through and severed by mighty rivers."[3]

Maclure was interested in the classification of rocks and avoided any discussion of the theory.

Merrill[4] quotes S. L. Mitchell (1818) upon the "Theory of Barriers." Mitchell, however, merely expanded the general theory from the viewpoint of the northern states. The theory had been in existence for at least seventy years prior to Mitchell's article. His work followed and amplified the opinions of Volney and other writers upon the topic.

Thomas Jefferson popularized the conception of barriers which he may have encountered at Philadelphia. Travelers in the United States generally visited Jefferson at Monticello. In the hall at Monticello they saw mammoth bones, "maps traced by the Indians on leather," and other curiosities. They talked with him upon Indians, climate, timber, Natural Bridge, and the natural wonders of Virginia. For years Mr. Jefferson served as a voluntary tourist's bureau. English travelers listened and sometimes disagreed, but French and German travelers with greater confidence in his opinions, left Monticello convinced of the truth of his scientific theories.

Jefferson's colorful description of the break in the Blue Ridge at Harper's Ferry placed the conception of barriers upon a firm footing for many years.[5]

"The passage of the Patowmac through the Blue ridge is perhaps one of the most stupendous scenes in nature. You stand on a very high point of land. On your right comes up

[2]Thomas Twining, "Travels in America 100 Years Ago," (1894), Harpers, New York, p. 99.

[3]J. F. D. Smyth, Esq., "A Tour of the United States of America," (1784), 2 vols., London.

[4]George P. Merrill, "The First One Hundred Years of American Geology," (1924), New Haven, Yale University Press, pp. 50–53.

[5]Thomas Jefferson, "Notes on the State of Virginia," (1800). Baltimore, W. Pechin, pp. 20–21. Many editions. The Notes were first written in 1781.

the Shenandoah, having ranged along the foot of the mountain an hundred miles to seek a vent. On your left approaches the Patowmac, in quest of a passage also. In the moment of their junction they run together against the mountain, rend it asunder, and pass off to the sea. The first glance of this scene hurries our senses into the opinion, that the earth has been created in time, that the mountains were formed first, that the rivers began to flow afterwards, that in this place particularly they have been dammed up by the Blue ridge of mountains, and have formed an ocean which filled the whole valley; that continuing to rise they have at length broken over at this spot, and have torn the mountain down from its summit to its base. The piles of rock on each hand, but particularly on the Shenandoah, the evident marks of their disrupture and avulsion from their beds by the most powerful agents of nature, corroborate the impression. But the distant finishing which nature has given to the picture, is of a very different character.— It is a true contrast to the foreground. It is as placid and delightful, as that is wild and tremendous. For the mountain being cloven asunder, she presents to your eye, through the cleft, a small catch of smooth blue horizon, at an infinite distance in the plain country, inviting you, as it were, from the riot and tumult roaring around, to pass through the breach and participate of the calm below. Here the eye ultimately composes itself; and that way too the road happens actually to lead. You cross the Patowmac above the junction, pass along its side through the base of the mountain for three miles, its terrible precipices hanging in fragments over you, and within about 20 miles reach Fredericktown, and the fine country round that. This scene is worth a voyage across the Atlantic. Yet here, as in the neighborhood of the Natural Bridge, are people who have passed their lives within half a dozen miles, and have never been to survey these monuments of a war between rivers and mountains, which must have shaken the earth itself to its centre."

A "lofty crag upon the margin of the river," from which Jefferson is said to have viewed the scene, was once called "Jefferson's Rock." Jefferson told Volney that he had taken his description from "the report of a French engineer, who, during the Revolutionary war had scaled the hill." This account of Jefferson was frequently quoted in American geographies where it may be found as late as 1850.

Count C. F. Volney, an authority of the times upon history and geography, visited the United States in 1795, and traveled extensively for three years. He hiked through rural America making observations upon climate, soils, and geology. Twining met him in 1795 and said "he was cold and satirical. . . . He was little pleased with America, and where he was not pleased he expressed himself with much severity." The following episode recorded from rural Virginia may have been typical of Volney:[6]

"Some thirty or more years ago, at the close of a summer's day, a stranger entered Warrenton. He was alone and on foot, and his appearance was anything but prepossessing; his garments coarse and dust-covered, like an individual in the humbler walks. From a cane resting across his shoulder was suspended a handkerchief containing his clothing. Stopping in front of Turner's Tavern, he took from his hat a paper, and handed it to a gentleman standing on the steps. It read as follows: 'The celebrated historian and naturalist, Volney, needs no recommendation from G. Washington.' "

Volney talked with Jefferson, Washington, "Mr. Barton" and many others, and his views were colored by their opinions. It seems more than probable that Volney developed the idea of barriers after his talks with Jefferson, although his views are stated as if they were original. Volney brought this theory into a position of the greatest importance in American geology.

He believed[7] that the Blue Ridge was once a great barrier and that the Great Lakes are a shrunken remnant of a great inland sea which stood behind it. He thought that the sea has broken through at Harper's Ferry and at other places. The breaks in the Blue Ridge were produced by stream erosion and by earthquakes. High gaps in the ridge were formed by the first efforts of the lake to reach the sea. Terraces along the Ohio he believed to be due to successive lower water levels as the barriers were lowered. Horizontal strata west of the ridges were deposited in this ancient sea and rivers washing in trees laid down the beds of coal. Coal beds in Virginia east of the Blue Ridge may have somehow been produced by earthquakes, although the beds near Richmond were laid down in a basin which was held in by rocks at the present Fall line.

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[6]Henry Howe, "Historical Collections of Virginia," (1845), p. 261.

[7]C. F. Volney, "Tableau du Climate et du Sol des Etats Unis d'Amerique, etc." (1803). Several editions. English translations by C. B. Brown, Philadelphia, (1804).

According to Volney's map, the great eastern barrier extends from the southern side of the St. Lawrence in Nova Scotia southwestward to include the White Mountains of New Hampshire, the Highlands of New Jersey, and the Blue Ridge to Alabama. Appalachian ridges run into this mountain chain in such a manner as to make many isolated interior basins. From Alabama, the chain swings sharply westward to the junction of the Tennessee and Cumberland rivers with the Ohio. Here the mountain was presumably broken by the Mississippi. The "Haute Louisiane" west of the river extends the highland westward to the Stony Mountains. This chain extends northward to the Mackensie River. He places an east-west mountain chain north of the Great Lakes from the Stony Mountains to Labrador. The St. Lawrence breaks through this chain and also through an inner chain which strikes across the east end of Lake Ontario from the Adirondack Mountains. His great inland sea or lake stood within this barrier of mountains. Volney made no definite attempt to explain the origin of the ridges.

French travelers followed Jefferson in their opinions upon American geology. It remained for the Marquis De Chastellux[8] to polish up the theory by using it to explain the origin of Natural Bridge in Virginia.

The first accurate survey of the bridge was made by Baron de Turpin under Count de Rochambeau and at the instigation of the Marquis De Chastellux. De Turpin took from "every part of the arch, and of its supporters" pieces of stone all of which were found to dissolve in aqua fortis and says that "these rocks being of a calcareous nature, exclude every idea of a volcano, which besides cannot be reconciled with the form of the bridge and its adjacent parts." Nor could a current of water break through here and make the bridge. Chastellux outlines the theory of lakes behind mountain barriers and says that rivers rising in the Alleghanies "have opened ways for themselves to the sea, by piercing the mountains at angles, more or less approaching to right angles, and forming more or less spacious valleys. Natural Bridge was formed by this process where water broke through." Other bridges formed in this manner have collapsed since.

While such views were held by famous men, Gilmer in 1815,

[8]Marquis De Chastellux, "Travels in North America," (1787), 2 vols. London.

after visiting the bridge with its owner, Jefferson, refused to accept this theory, and in this manner Jefferson lived into the day of modern science. In a remarkable article before the American Philosophical Society Gilmer said[9] that the bridge was due to solution effects in limestone.

Observers at an early date attacked Volney's conception of inland lakes. David Thomas,[10] an astute New York traveler, made a westward journey by coach in 1816 to study the "Waubash lands in the New Purchase." Wherever the coach stopped, he continually tested Volney's theories against personal observations. Although Volney was "said to be a genius of the first order in physical geography," he found that the knobs at New Lexington which Volney said once held back a great lake, could not have done so, since the rocks below their summits are not alluvial but are calcareous and siliceous (secondary). He condemns the tendency of the geologists of the time to "imagine that every valley which pours a stream through mountain ridges, was formerly the bed of a lake." He states that the Blue Ridge, for example, was too massive for its breaches to have been made by pressure of water, nor could these ruptures have been made by earthquakes as Volney suggested. He says that Volney's theory is absurd because the Knobs do not extend across the valley of the Ohio or the White River, because the secondary strata including coal beds and limestone, are not the kind of rocks to be laid down in recent lakes, and that the marine shells in the rocks west of Volney's lake can not be explained according to his principles."[11]

The conception of mountain barriers and inland seas died obscurely. Scientists lost faith in it before a better theory was advanced. Writers of geological texts avoided it. Except in

[9]Francis W. Gilmer, "On the Geological Formation of Natural Bridge, Virginia," (1818). Trans. Am. Phil. Soc., vol. I, new ser., No. 13.

[10]David Thomas, "Travels Through the Western Country in the Summer of 1816," (1819), Auburn, N. Y.

[11]Although beyond the scope of this paper, it should be said that from his study of coal and invertebrate fossils, Thomas caught a glimpse of organic evolution 40 years before the publication of the Origin of Species. He says, p. 260:

"The grand order of our system is to spring, to flourish and to die. The period for which many* plants and animals were intended, is past; and like the individuals of every race, whole species have perished. The space assigned them has been filled; new orders arise; and combinations more beautiful are unfolded. The sheep tenants the deserted ranges of the wolf, and the yellow gleams of harvest, succeed the dark foliage of the forest.

*It is questionable whether the beds of coal are the remains of any vegetable species now in existence."

school geographies, little mention is made of this theory after 1820.

In 1821, Wilson[12] attacked Volney's Views, Jefferson's Notes, and the opinions expressed in the appendix to an early American edition of Cuvier's theory. He said that the barrier does not have sufficient height to pond up a large lake, and that the lake could not have broken through at six points at once.

Charles Lyell visited America in 1841–42. He calls special attention to the *absence of lakes in the Appalachians*. He may have been thinking of the supposed lakes when he said "it is singular that there are no lakes in the Appalachian chain, all the rivers escaping from the longitudinal valleys through gorges or cross-fissures, which seem invariably to accompany such long flextures of the strata as characterize the Alleghanies or the Jura."[13]

From discussions which arose upon the origin of these "cross-fissures" came the conception of antecedent streams, and the development of modern physiography by Davis.[14]

Although abandoned many years ago by science, the theory of lakes and mountain barriers is not entirely dead to this day. It is still encountered in rural Virginia and perhaps at other places, where it is probably a survival from the past. Sometimes it arises spontaneously. Dyott,[15] a South American explorer has recently invoked the theory to explain the geology of the Amazon valley.

In 1902 the existence of an inland lake held back by the Blue Ridge was suggested by the writer of a soil report.[16] Because waterworn cobbles occur in the fans at the western slope of the Blue Ridge "this talus slope has been subjected to the action of water, probably while forming a shore of an inland sea.

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[12]J. W. Wilson, "On the Bursting of Lakes Through Mountains," Am. Jour. Sci., (1821), pp. 252–3.

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PROTOZOAN PARASITES OF THE ORTHOPTERA, WITH SPECIAL REFERENCE TO THOSE OF OHIO[1]

I. Introduction and Methods

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INTRODUCTION

This work is primarily a distributional and ecological study of the protozoan parasites of Ohio Orthoptera, exclusive of the domestic cockroaches, *Blattella germanica*, *Blatta orientalis*, and *Periplaneta americana;* and also excluding the wood-eating roach, *Cryptocercus punctulatus*. The Orthoptera were taken from July, 1932 to October, 1933 in Franklin County and the six contiguous counties of central Ohio, and in the southeastern portion of Washington County in southeastern Ohio; also sporadically in four other counties of Ohio and the Lake Michigan sand dunes of Indiana.

Specifically, the purpose of this study was to determine the distribution of protozoan parasites in all available species of Orthoptera in a given region, and to learn something of the relationship between life history and ecology of parasite and life history and ecology of host. In addition, a classified, annotated list of the protozoan parasites of the Orthoptera of the world was compiled from the literature, a key for the identification of these protozoa was constructed, and a complete bibliography was assembled.

A comprehensive survey of the protozoan parasites of all the Orthoptera of a given geographic region has not previously been made, although S. F. Bush has published (1928) such a study of the Gregarinida present in the Acrididae (locusts or short-horned grasshoppers) of a region in South Africa.

The terminology of this work has been selected, for the most part, from Calkins, 1933 (general protozoology), Wenyon, 1926 and Kudo, 1931 (parasitic protozoology), and Watson, 1916, p. 10 (Gregarinida).

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[1]Contributions from the Department of Zoölogy and Entomology, number 112, part 1.

Professor W. J. Kostir, of the Department of Zoology and Entomology, The Ohio State University, suggested the possibilities in this field and kindly undertook the supervision of the research. Mr. Edward S. Thomas, curator of Natural History of the Ohio State Museum, helped greatly in many ways, particularly in the collecting and identifying of the Orthoptera. Dr. Theodore H. Hubbell, of the Zoology Museum, University of Michigan, generously devoted much time to the correction and revision of the classified list of orthopteran hosts examined by other investigators. The following persons also rendered valuable help: Dr. A. N. Caudell, Entomologist, United States National Museum; Dr. Richard R. Kudo, Department of Zoology, University of Illinois; Mrs. Ethel M. Miller, Botany and Zoology Librarian, The Ohio State University; Professor Catherine B. Semans, Youngstown College; and Dr. B. P. Uvarov, British Museum of Natural History.

METHODS

Orthoptera were collected extensively throughout central Ohio and a portion of Washington County, and less so, in several other localities, with a view to obtaining as large a number of species from as great a variety of habitats as possible. There was no thought of collecting at regular intervals from the same localities, as that was not possible in the time available. The majority of the collections were made during the summer and early fall of 1933; hence no attempt was made to compare results from the same seasons (summer and fall) of the two different years; and, also, the number of specimens of no one species was great enough to justify such a procedure. Most of the collecting was done by net sweeping, although all known methods were used.

The following ecological factors were recorded for each locality in which collections were made: Uppermost geological stratum, kind of soil, topography, average soil moisture and soil pH, plant association, and the general weather conditions. The pH was determined by the use of the Soiltex colorimetric method—a simple modification of that of M. F. Morgan (1927, p. 387; also described by E. F. Snyder, 1928, p. 18)—supplemented by the Hellige colorimetric method. In the Soiltex method, a small portion of pulverized soil is placed in a trough of waxed paper which is held on a slant. Several drops of indicator solution are dropped on the upper end of the soil

until a globule of liquid appears at the lower end. A small, clear drop of the liquid is drawn away from the soil with a clean knife blade and its color is compared with a color chart. An average discrepancy of 0.32 occurred between determinations made by this method and the quinhydrone electrometric method on four samples of soil covering a range of 5.58 to 7.71. The error was, no doubt, partly the result of the presence of pigments in the soil. The same method was used in determining the pH of the anterior end of the mid-intestine of thirty-seven orthopteran specimens, in an attempt to correlate parasite prevalence with degree of acidity.

The general weather data are omitted from this paper because these were found to be of little significance over so comparatively short a period of collecting.

The captured insects were kept alive in glass jars, usually containing pieces of paper or dry plant material to reduce the humidity—apparently the greatest factor in the loss of insect material—and also to prevent the insects from striking one another. A rapid change of temperature was even more deleterious than high humidity, but it did not occur so often. The examination was usually made immediately after taking the insects, hence, except in special cases, no attempt was made to provide them with food.

In preparation for the examination of insects for parasites, a thorough study of insect morphology was made, including the histology of the alimentary tract of the differential locust (*Melanoplus differentialis* (Thomas, 1865) Brunner, 1885).

The perfected routine as used in the examination of the insects may be resolved into the following steps:

1. As a preliminary step the following information was recorded: Accession number of the insect; age and sex; the locality (characterized ecologically in a field record-book) where the insect was taken; the dates of capture and examination; and, later, the parts examined and the percentage of saline (0.85% sodium chloride) solution used in the temporary mounting. An experiment on the effect of three percentages of saline (0.65%, 0.75%, 0.85%) and distilled water on a delicate gregarinid (*Gregarina galliveri* Watson) which was available in comparatively large numbers, showed that there was little appreciable difference, except with the distilled water, where distortion (rounding) was produced somewhat earlier.
2. The insect was slit anteriorly on the midventral line with a small pair of scissors. In rare cases where the insects were extremely small and active, they were anesthetized with tobacco smoke. The severing of the ventral nerve trunk in the thoracic region proved to be no more effective in stunning the insect than the longitudinal slitting.

3. The cut edges were pushed well apart with a pair of forceps and, with a second pair, the alimentary tract was broken from its extreme connections and removed to a clean glass slide into a few drops of saline solution. (See step 11 for the method of examining the intestinal contents of cockroaches from flagellates and ciliates.)

4. The insect was pinned and labelled.

5. The slide mount was placed on the stage of a low-power (×10.5 to ×30) binocular microscope. The alimentary tract was broken apart by means of two pairs of forceps—cleaning them after each operation—into fore-intestine, mid-intestine (removing the enteric ceca for separate consideration), and hind-intestine—or whatever divisions of the latter were present. Each section was placed in a separate drop of saline solution.

6. The alimentary tract and malpighian tubules were examined externally for celomic parasites, and then, with two stout insect pins (cleaned after each operation), each section was torn into small shreds, the number and position of the larger Gregarinida being noted. The malpighian tubules were left more or less intact for separate examination.

7. The drops of saline solution impregnated with gut contents were spread over the slide to make them as thin as possible and were examined—usually without a cover-glass, the use of the latter making it difficult to obtain organisms for permanent staining—with the ×60–100 combination of the microscope, stepping up the magnification as high as ×880 for minute flagellates. The examination was facilitated by the use of a graduated mechanical stage.

8. In a thorough examination of the temporary mount, everything of apparent significance was recorded, measurements of the organisms being determined by means of a calibrated ocular micrometer. Drawings were made with or without the use of a camera lucida, depending upon the amount of movement in the organisms. Weak stains were used at the start but were abandoned in favor of the saline mount followed by the permanent staining of all representative parasites, including helminths.

9. Cysts of interest, if not permanently mounted, were put in a watch glass or the well of a concavity slide and kept in a moist chamber, but a technique for invariably bringing about cyst dehiscence was not perfected, as the number of cysts was too small.

10. Representative gregarinids (i. e., of the order Gregarinida) were removed, by means of a capillary pipette, to a watch glass for fixing and staining. It was found to be impracticable to make permanent mounts of flagellates from saline, as it was difficult to make them adhere to glass.

11. The fixing and staining of flagellates and ciliates (from step 3): A portion of the hind-intestine—usually the colon—of cockroaches was mixed with a small drop of sterile horse serum (adhering agent) on a clean cover glass, spread over the entire surface of the latter, and plunged into a fixing agent (preferably Kahle's fixing fluid: 32%, 95% ethyl alcohol; 11%, 40% formaldehyde; 4% glacial acetic acid; 53% distilled water) in a syracuse watch glass for about two hours;

then it was passed through 70% and 50% alcohol down to 30%, at fifteen-minute intervals, and stained ten to fifteen minutes by Ehrlich's hematoxylin (not longer, as in the case of other hematoxylin methods, otherwise overstaining results), and back up through the same alcohols to absolute alcohol and then xylol for the mounting in balsam.

12. The fixing and staining of Gregarinida (from step 10): Instead of using adhering agents, which created an undesirable background when stained (except for the smallest specimens), the saline was removed and the fixing agent (preferably Kahle's) applied by means of a capillary pipette—the method used throughout the entire fixing and staining procedure. Kahle's fluid was left about two hours, followed by two changes of 70% alcohol (two hours each), 95% alcohol (two minutes), the stain, Fast Green FCF (two minutes), 95% alcohol again (one minute), absolute alcohol (five minutes). The organism was placed by means of a capillary pipette directly into balsam (mixed with xylol) on a slide cleaned with xylol and a clean cover-glass was applied.

The Kahle's-Fast Green method is a slight modification of that suggested by C. H. Kennedy (1932) for the staining of the cytoplasm of the insect cell, and was discovered to be effective for the Gregarinida through the staining of sections of the alimentary tract of *Melanoplus differentialis* (Thomas) containing sporonts of *Gregarina rigida* (Hall). No additional nuclear stain is necessary, as the refractive index is quite different from that of the cytoplasm. Several other staining methods were tried, but none appeared to be as satisfactory as that described above.

All permanent slide mounts were placed in the author's private collection.

13. Every insect examined, irrespective of whether or not it was a host, was taken to Mr. Edward S. Thomas for identification. Many of the specimens were retained for the Ohio State Museum collection and were so labelled that they may be readily referred to. The remaining specimens (all of the hosts and many of the non-hosts) were placed in the author's private collection.

14. The permanent slide mounts were examined, and everything of significance was recorded, this information being compared with that acquired from the examination of the temporary mounts. The biometric method of M. E. Watson (1916, p. 42), modified, was adopted for the description of the Gregarinida. At least one representative gregarinid individual from each host individual was described in detail. The position of the nucleus was recorded, but as that structure may shift its position somewhat, as was observed in at least one case, it is doubtful that the information will prove to be of much significance. Hence, it will be withheld for further consideration.

TERMINOLOGY OF THE ALIMENTARY TRACT

Because of the confusion existing in the use of terms describing the divisions of the alimentary tract of Orthoptera, it is well to consider them at this time.

The embryological divisions of the alimentary canal are

the fore-, mid-, and hind-intestine. In the adult fore-intestine ("fore-gut"), the following parts, from the anterior to the posterior end, are recognized: Salivary glands—anterior evaginations, rudimentary or lacking in the Acrididae; esophagus; crop—an esophageal expansion; and gizzard ("proventriculus"), rudimentary in the Mantidae, almost vestigal in the Phasmidae, and vestigal or wanting in the Acrididae. The mid-intestine ("mid-gut," "ventriculus," "chylific stomach") consists of the enteric ("gastric," "pyloric") ceca—anterior evaginations, and the mid-intestine proper; the number of enteric ceca in the various families is as follows: Blattidae and Mantidae, eight; Phasmidae, none; Acrididae, six; and the Tettigoniidae, Gryllacrididae, Gryllidae, two—these being sac-like, while those of the other families are more tubular. The hind-intestine ("hind-gut") consists of the malpighian tubules—anterior evaginations variously grouped in the different families; small intestine—only in certain Blattidae; large intestine ("colon"); and the rectum—in many, little more than a colic expansion.

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Pyrethrum Flowers

Since the publication of the first edition of this book, a number of important facts concerning pyrethrum have been discovered and published in various journals. The author has reviewed all these papers and incorporated the new ideas in the recently published second edition. Three hundred eighty-seven references have been added to the bibliography. Many of the chapters have been enlarged, and some of these additions are recent work in isolation of pyrethrins, new chemical and biological methods of assaying pyrethrum products, additional information on livestock sprays, the decomposition of pyrethrum products in storage and the use of antioxidants to prevent the loss of toxic constituents, recent uses of pyrethrum as sprays and dusts, and the final chapter has been greatly enlarged and concerns the cultivation of pyrethrum in the United States. The book should be invaluable for teachers, students, and research workers in insecticide control.

—R. H. Davidson.

Pyrethrum Flowers, (Second Edition), by C. B. Gnadinger. xvi+371 pp., 41 pls., 12 figs. Minneapolis, McGill Lithograph Company, 1936.

MOHICAN FOREST PARK

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College of Wooster

One of Ohio's most scenic areas, unknown to many people, is located in southern Ashland County. It is easily accessible to tourists from any part of the State, as there are roads leading into the park from all sides. Recently a group of the Civilian Conservation Corps constructed roads, new trails and other features, greatly improving the area as well as making it more accessible.

The original part, an unorganized unit, contained 656 acres which were so located that the development of the area as a recreational center was all but impossible. Recently, enough land has been purchased and placed under option by the State to give the park an area of about 1,500 acres. Eventually it will contain approximately 2,100 acres. One of the dams proposed as part of the Muskingum Project (Pleasant Hill Dam) is being constructed in the Clear Fork gorge, at a point above the main area included within Mohican Forest Park.

The beauty of this park is not surpassed by any in Ohio unless it be the parks in Hocking County, in the southeastern part of the State. Mohican Forest Park lies, for the most part, within a heavily wooded, deep, narrow gorge, the valley of the Clear Fork, a tributary of Mohican River. Precipitous trails lead from the rim of the gorge down to the stream through a dense forest of hemlocks and pines with numerous hardwoods. The contrast in color is at all times beautiful, but especially so in the Fall when the hardwoods are in all their brilliance. According to R. R. Paton, Assistant State Forester, this forest contains the largest area of native white pine remaining in Ohio. Reforestation of the open areas has been progressing, pines being used almost entirely for this purpose.

If one enters the park from the south, he can obtain from the bluff of the gorge, the most spectacular view in the region. Here from a flat upland, one can look over a precipitous cliff, far down on the waters of the Clear Fork.

PHYSIOGRAPHY AND DRAINAGE CHANGES

The question which comes to one as he studies the region is why so deep and narrow a gorge is present here, when nothing

like it occurs in this section of Ohio. The answer lies in its physiographic history. A glance at the map shows that the valley of the Clear Fork narrows in the direction of flow and is narrowest at the position of the col in Mohican Forest Park, beyond which it widens, indicating that in preglacial and interglacial time, at the narrowest portion of the gorge, there was a

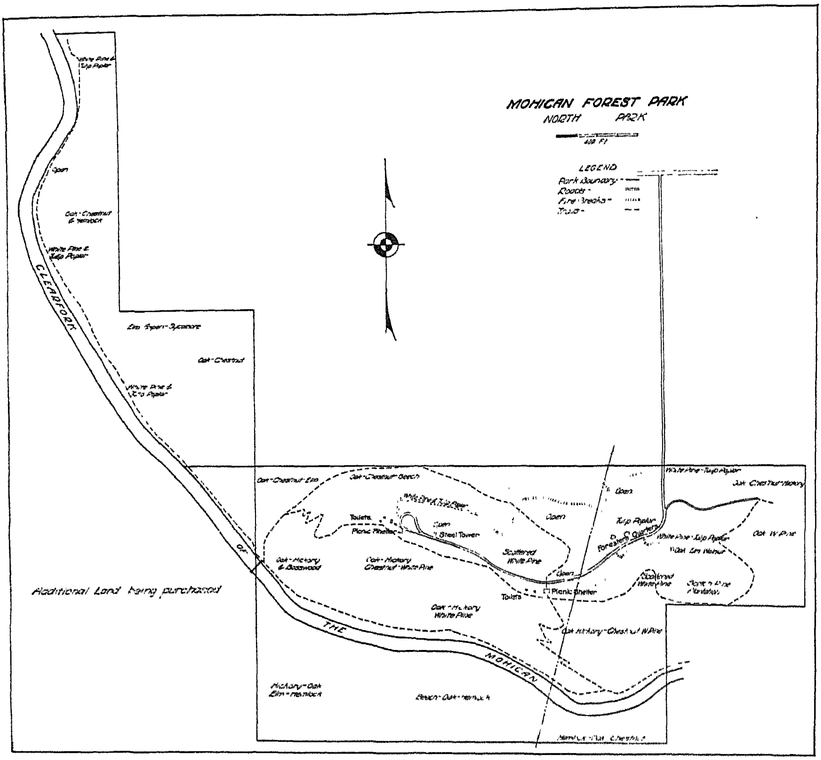

FIG. 1. Mohican Forest Park, north portion.

divide between two tributaries flowing in opposite directions. Due to the blocking of the drainage, the water was forced over the divide into Mohican River which flows south.

In an earlier paper[1] the present writer suggested that Clear Fork gorge might have had its origin as early as the

[1]Ver Steeg, Karl. Drainage Changes in the Vicinity of Loudonville, Ohio. Ohio Journal of Science, September, 1931, pp. 368–376.

Illinoian ice invasion. White[2] believes the diversion across the col occurred during the Wisconsin stage of glaciation and bases

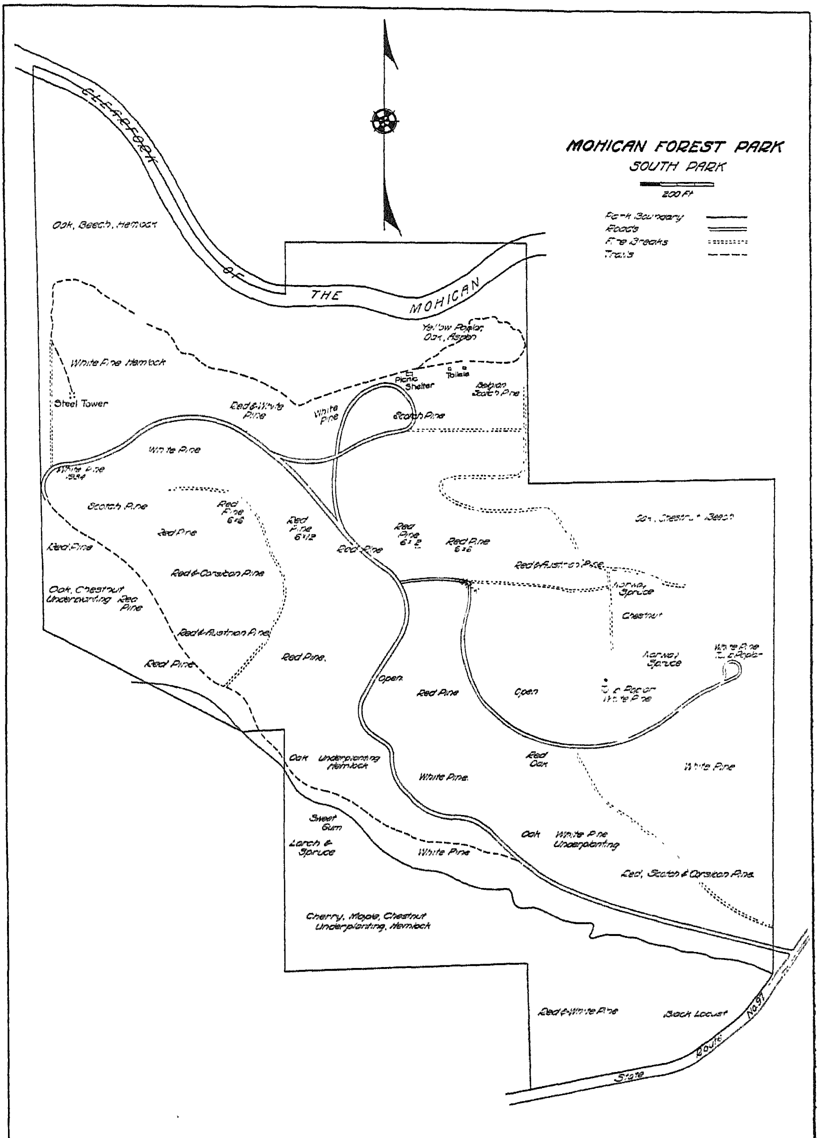

FIG. 2. Mohican Forest Park, south portion.

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[2]White, George W. Drainage History of North-Central Ohio. Ohio Journal of Science, November, 1934, pp. 365–382.

his conclusions on the extreme narrowness of the col and its position immediately south of the Wisconsin glacial boundary. Although the present writer does not abandon the possibility that the diversion may have occurred during the Illinoian stage of glaciation, he believes that White's arguments have much in their favor and is willing to accept his interpretation as a basis for discussion.

It is now believed that the valleys in Ohio, in pre-Illinoian time, were deepened considerably during what is known as the Deep Stage. After the Kansan or pre-Kansan glaciation, during the Deep Stage, the Clear Fork occupied a deep, narrow valley. The tributaries flowing from the divide marked by the col, northwest to Clear Fork and east to Pine Creek, also occupied deep, narrow valleys during this time. If we accept White's interpretation, the Killbuck lobe of the Wisconsin ice-sheet advanced far enough south to dam the Clear Fork. The ponded waters at first found an outlet through the divide at the head of the valley of Smoky Run, southwest of Butler, and escaped into the valley of East Branch of Kokosing River near Ankenytown. This outlet was not used very long, for the Scioto lobe of the glacial advanced to the east of Ankenytown and far enough to the east of the outlet to close it. The ice of the border of the Killbuck lobe melted away from the old valley in northeastern Worthington Township so that the waters again followed the old course to the southwestern corner of Green Township. The edge of the ice prevented the water from entering the Black Fork valley and ponded it to a height sufficient to flow over the divide into the headwaters of a tributary of Pine Run, and eastward to the point where Pine Run and Black Fork meet. The chasm of the Clear Fork is the result of erosion during the Deep Stage, Wisconsin and postglacial time. The buried valleys[3] in north-central Ohio were deepened during this stage and compare in depth and narrowness with Clear Fork gorge. The extreme narrowness at the col in Mohican Forest Park is the result of recent postglacial erosion, probably rapid while silt-laden water from the Wisconsin ice-sheet passed over it. After the ice melted away the streams continued to flow as at present.

The Clear Creek gorge in Mohican Forest Park is an excellent example of a youthful valley. It is a quarter of a mile wide

[3]Ver Steeg, Karl. Buried Topography of North-Central Ohio. Journal of Geology, Volume XLII, No. 6, August-September, 1934, pp. 602-620.

across the top, tapering down to about 200 or 300 feet at the bottom. The characteristic features of youth are its V-shape,

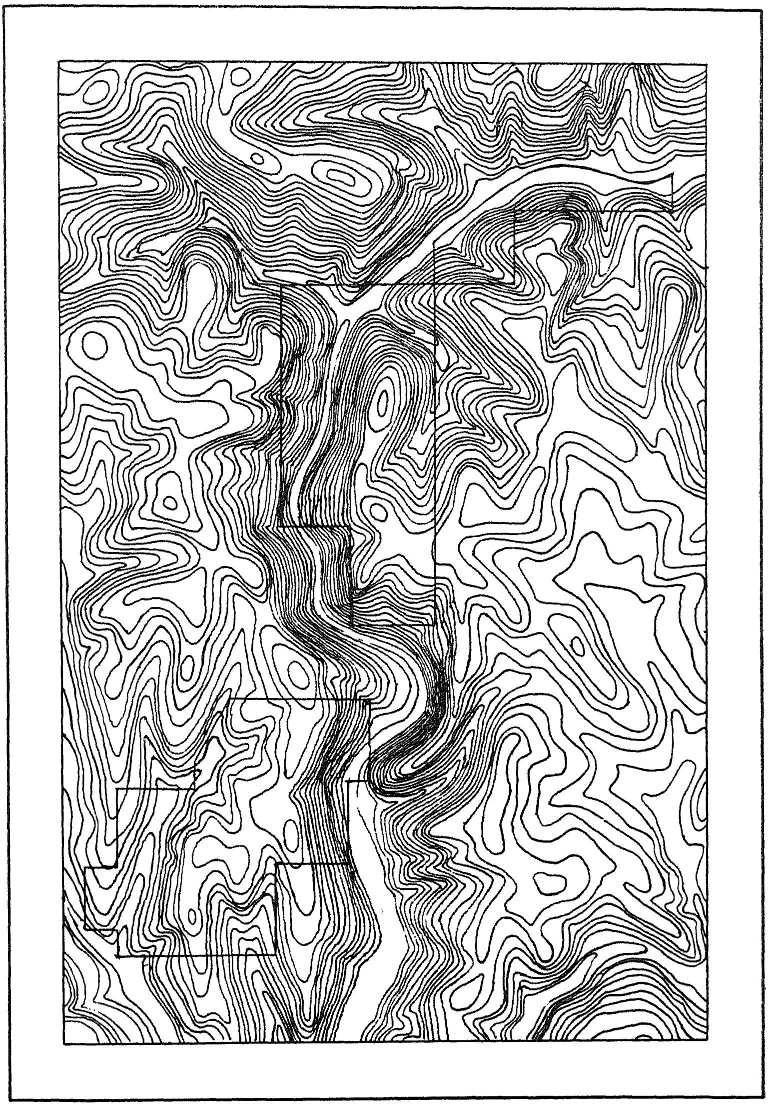

FIG. 3. Topographic Map of Mohican Forest Park, showing boundaries. (Contour interval—20 feet.)

steep sides with bold rock outcrops forming prominent cliffs, overlapping spurs, rapids, and the absence of a flood plain, indicating that the stream is actively cutting down its valley.

The presence of a massive sandstone formation, a hundred or more feet thick, which forms the rim of the gorge, is largely responsible for its narrowness. This resistant formation has prevented the rapid widening of the valley by weathering and erosion, retaining the narrow, gorge-like character for a longer period of time. Furthermore, the short period of time, from the Wisconsin to the present, has not been sufficiently long to enable the erosive agents to widen the valley and reduce its slopes to a lower angle of inclination. The youthful appearance of the valley is in harmony with the fact that a divide existed here in preglacial and possibly interglacial time, through which has been cut the postglacial gorge.

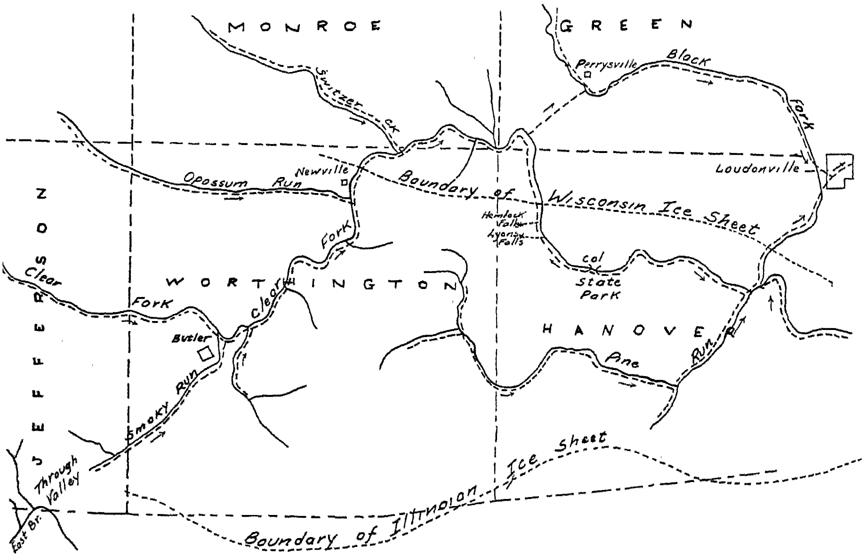

FIG. 4. Interglacial and present drainage lines of Mohican Forest Park region.

One of the most attractive spots is Lyons Falls. Here, at the head of a narrow ravine, leading to the Clear Fork, the water dashes from the upland over a forty-foot cliff which has been undermined, giving it the form of an amphitheatre. This cave, if it may be so called, resembles Ash Cave in the Hocking County area, except that the latter is much larger. It is evident that the combined weathering of the sandstone and pot-hole action are responsible for the undermining of the cliff. The undercutting or sapping process has been the cause of the recession of the falls. The narrow gorge with its overhanging

FIG. 5. Aerial photograph of Mohican Forest Park and surrounding territory.
(Loaned by Fred L. Smith, director, Ohio Bureau of Aeronautics.)

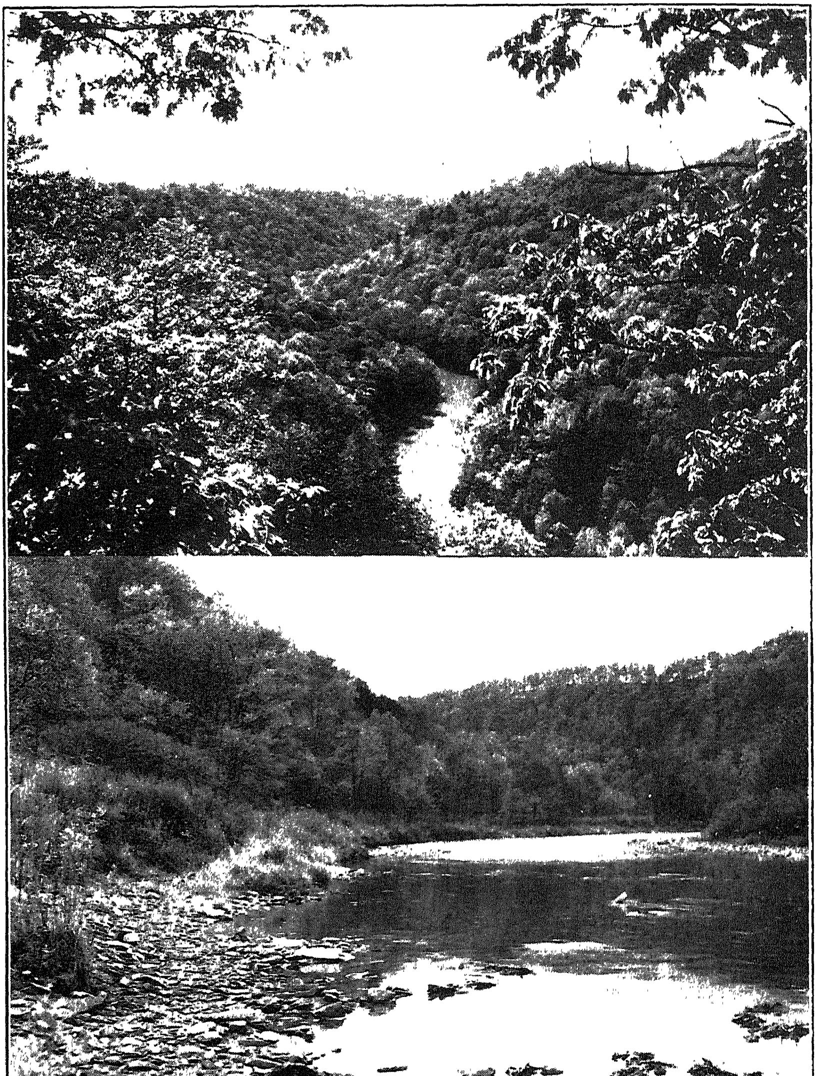

FIG. 6. Two views of Clear Fork Gorge.

cliff at its head, is similar to many of the glens cut in massive sandstone formations in other parts of the country. Hemlock Falls, beyond the ridge north of Lyons Falls, and located on another tributary of the Clear Fork, is smaller, but illustrates the processes of recession better than at the larger falls. Here large masses of sandstone have toppled from the semicircular, overhanging cliff which has a pot-hole at its base.

GEOLOGICAL FORMATIONS

The rock formations which outcrop in Clear Fork gorge belong to the Waverly series and were laid down in Lower Mississippian time. Two members of the Waverly series, the Cuyahoga and Logan formations, make up the succession of beds exposed in the gorge. Only a part of the Cuyahoga formation is exposed; the valley floor is cut in it and it extends well up the sides of the valley. The Logan formation which overlies the Cuyahoga is composed chiefly of sandstone, whereas a larger proportion of shale makes up the Cuyahoga. The Clear Fork flows over beds which are composed, for the most part of shale, with thin sandstone layers interstratified. With the exception of a few thin beds of conglomerate, the entire succession of beds is sandstone and shale, the total amount of sandstone exceeding the shale in thickness. The high cliffs which form the rim of the gorge and add so much to the scenery of the park, are composed of the thick-bedded sandstones of the Logan formation.

A section of the rock formation in the gorge, from the stream level to the rim and beyond to the upland, are approximately as follows: Up to about 55 feet above the level of the stream, thin beds of sandstone make up the series. About 30 feet of sandstone with shale horizons follows. There appears at approximately 80 to 85 feet above the stream, a bed of conglomerate about one foot thick. This stratum is composed of pebbles about as large as a pea, cemented by iron oxide. It is a persistent formation and is the source of water in the region which it underlies. Above the conglomerate lies about 10 feet of thick-bedded sandstone, upon which rests a thick succession of slabby sandstone interstratified with occasional strata of shale, the whole approximately 140 feet thick. Above this and extending up to the rim of the gorge is a thick succession of sandstone beds, constituting the main part of the Logan formation.

FLORA

The following description of the flora of Mohican Forest Park was supplied by Assistant State Forester R. R. Paton, of the Ohio Agricultural Experiment Station.

The forest in the valley of the Clear Fork, in the area enclosed by Mohican Park, varies widely in its composition, due largely to the depth of the gorge. The adjacent highland is farm land, reaching to the summit of the valley slopes. The native forest of the gorge has encroached on the adjacent farm land in places. This volunteer growth, or old field type, is composed of staghorn, sumach, pignut, mockernut, shellbark hickories, white pine (where seed trees are present), large tooth aspen, hawthorn, sassafras, black cherry, red maple and an occasional red cedar.

The forest in the valley changes as it progresses from the top of the valley wall or ridge type, through the upper slope, middle slope, and lower slope to the bottoms, and the south wall is characteristically different from the north wall. The ridge forest on both sides is essentially the same and is composed of white, red, scarlet, black and chestnut oaks, red maple, the hickories, an occasional white pine and formerly chestnut. On the south wall, down from the ridge to the upper slope, hemlock, beech, hard maple, black cherry, occasional yellow poplars, white ashes and ironwoods (*Ostrya Virginiana*) come into the forest composition. The hemlock begins at the top of the valley wall, while the chestnut oaks become noticeably fewer in number within a short distance below the ridge. The middle slope forest is denser, the beech, yellow poplar and white ash are more numerous, shad bush appears and the hickories become less numerous. The lower slope forest is still denser with a great variety of species. The hemlock is common, in places being the predominant tree; the beech, hard maple, yellow poplar, white ash and shad bush are more common and butternut, black walnut, basswood, white red elms, black alder, blue beech, Canadian yew, pawpaw, mountain maple (*Acer Spicatum*), witch hazel, spice bush and an occasional yellow birth is found. This is a typical northern beech, maple, hemlock forest, with species occurring here which are rare in Ohio, namely, hemlock, yew, mountain maple and yellow birch. The hickories and oaks are present but not numerous. In the bottoms, sycamore, willows, buckeye (*Resculus Glabra*), haw-

thorn, bladdernut and dogwood are found near the stream. The north slope of the gorge is similar to the south side on the middle and upper slopes except for the substitution of white pine for the hemlock. The lower slopes have a higher percentage of oaks, fewer yellow poplars, hard maples and beech and no Canadian yew, mountain maple, black ash or yellow birch.

Bailey's Histology

This well known text was thoroughly revised and greatly improved in the seventh and eighth editions. The present (ninth) edition conforms in organization and style to the last edition and is the work of five collaborators, all members of the Anatomy Department of the College of Physicians and Surgeons, Columbia University. Four chapters have been rewritten and most of the others have been reorganized or revised to incorporate new material. The book is well balanced and the organization is logical. The cell is first considered as a structural and functional unit, attention being directed both to fixed preparations and the living cell as seen in tissue culture and other preparations. Then the various tissues are described and finally the several systems with their respective structures and organs. In each section the histogenesis of the particular tissues is briefly given. In many instances the life cycle and ultimate fate of special cells are indicated. Occasional references are made to gross anatomical relationships to facilitate orientation and the more frequent use of such references would probably be welcomed by the average student. At the outset the authors recognize that structure assumes its fullest significance only when it is correlated with function and this thesis is carried throughout the text. Certainly this is good pedagogy for memory rests upon interest and association and the student will remember structure to the degree that he is able to interpret it in terms of life processes. This text may be confidently recommended for teaching purposes as a clear and straight-forward treatment of the subject.—O. C. Woolpert.

Bailey's Textbook of Histology, by various authors. Ninth edition. xvi+773 pp. Baltimore, William Wood & Co., 1936. $6.00.

Gems

A student who takes geology sooner or later comes to his instructor with a question concerning gems. Usually the instructor refers him to some trade article or else perforce to some technical and specialized report on one or at the most two kinds of gems. This new book on gems has as a subtitle "A Popular Handbook." It more than justifies the name. The first four chapters discuss the ancient use of gems and the development of the art and styles of cutting them. The diamond is taken up first, followed by a brief discussion of famous diamonds. Other precious stones are discussed, followed by accounts of semiprecious stones. Then is discussed chrysoberyl, opal, quartz gems, opaque gems, and unusual gems such as anatase, andalusite, benitoite, cassiterite, cyanite, hematite. Organic gems such as pearls and amber are discussed in chapter 16. A general bibliography is followed by a six-page descriptive table of gems. This table gives in a concise manner the name, mineral composition, color, transparency, hardness, specific gravity, occurrence, and usual cutting methods.

This book fills a long felt want. It is well and interestingly written, the style is smooth and it holds the interest. The illustrations are excellent and so placed as to greatly enhance the text.—Willard Berry.

The Study of Gems, by Herbert P. Whitlock. 206 pages. New York, Lee Furman, Inc., 1936.

TWO HEMIPTEROUS ENEMIES OF THE MEXICAN BEAN BEETLE IN OHIO[1]

WM. C. STEHR
AND
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Since the World War the Mexican bean beetle, *Epilachna corrupta* Muls., has been a serious pest of beans in Eastern United States. A number of native parasites and predators of the beetle have been reported by Howard and English ('24) and Howard ('30). Quantitative data are not given for any of the predators and parasites. It may be of interest to record a little quantitative data regarding two predators, one of which has not been recorded as a predator of the bean beetle previously.

On July 21, 1933, the senior author found a female of the pentatomid bug, *Perillus circumcinctus* Stål, feeding on an adult Mexican bean beetle. The pentatomid was placed in a cage with a bean plant and each morning ten adult bean beetles not over two days old were placed in the cage. All beetles were removed from the cage each day and the numbers killed by the pentatomid recorded. For the first week a control cage with the same number of beetles was observed. In eight days only one dead beetle was found so the control was discontinued since it was evident that the natural death rate among the young beetles was very low.

The maximum number of beetles killed on any one day was five and the minimum number one. A total of 85 bean beetles were fed upon in 27 days of observation. This is an average of 3.15 beetles per day. *Perillus circumcinctus* Stål has not previously been recorded as a predator on Mexican bean beetle.

On July 7, 1935, the junior author (W. F.) found a nymph of the reduviid, *Arilus cristatus* (Linn.) feeding on Mexican bean beetles. This nymph was placed in a cage with a bean plant and both adult and large larval bean beetles were introduced daily. The full data for this nymph are given since they show so clearly the influence of moulting on the feeding habits of this reduviid.

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[1]Paper No. 11, Department of Biology, Ohio University, Athens, Ohio.

Reduction of feeding began on July 9 and 10, and on July 11 and 12 no food was taken. On July 13 the last nymphal moult occurred. On the day following no food was taken and on the next three days only larvae were attacked. On July 18 the adult beetles were again attacked and formed the bulk of the food until August 1. On August 2 no food was taken and on August 3 the insect moulted again and became an adult. During 28 days it had consumed 69 adult beetles and 22 large larvae, thus accounting for 91 beetles altogether. This is an average of 3.25 beetles per day.

TABLE I

Mexican Bean Beetle Adults and Larvae Fed upon by *Arilus cristatus* (Linn.) During Period of Observation

DATE	FOOD		DATE	FOOD		DATE	FOOD	
	Adults	Larvae		Adults	Larvae		Adults	Larvae
July 7	5	4	July 17	0	1	July 27	2	2
July 8	4	2	July 18	3	2	July 28	3	0
July 9	3	0	July 19	2	2	July 29	4	0
July 10	2	0	July 20	3	1	July 30	3	1
July 11	0	0	July 21	4	0	July 31	2	1
July 12	0	0	July 22	2	0	Aug. 1	4	0
July 13	0	0	July 23	5	0	Aug. 2	0	0
Moult	Last N	ymphal	July 24	6	2	Aug. 3	0	0
July 14	0	0	July 25	8	0	Moult,	to adult	
July 15	0	2	July 26	4	0	Observa	tion	
July 16	0	2				discon	tinued.	

Arilus cristatus is more common in Southeastern Ohio than *Perillus circumcinctus*, but neither is present in large enough numbers to be effective as a natural control. This is in accord with previous reports of natural enemies of the Mexican bean beetle in Eastern United States. From the standpoint of the biology of these species it is of interest, however, to record their capabilities.

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STUDIES OF THE GENUS SCAPHOIDEUS (HOMOPTERA, CICADELLIDAE)

PART II. NINE NEW NORTH AMERICAN SPECIES AND DESCRIPTIONS OF FIVE MALE ALLOTYPES

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In a recent paper[1] (Part I) the genus was discussed and seventeen new species were described on the basis of the internal male genital characters. The present discussion is a continuation of this study using the internal male structures to establish several species already described, from females only, by Professor Herbert Osborn. The allotypes of these species are placed with the types in the Osborn Collection. Several species are described also which belong to the *productus-carinatus* group and which have previously been confused with these two species.

Scaphoideus veterator n. sp.

Resembling *frisoni* in form and general appearance but paler in color and with distinct genitalia. Length, 6–7 mm.

Vertex strongly produced and sharply angled, a little longer at middle than basal width between eyes.

Color: Face pale brown with at least two dark arcs above. The dark line just beneath margin of vertex and the one just above interrupted at middle. Vertex pale, median transverse band reddish brown, central portion darker. Pronotum brown with a paler transverse band behind eyes. Scutellum brown, the apical half white. Elytra white tinged with brown, veins dark brown.

Genitalia: Female last ventral segment with posterior margin roundedly produced, the apex slightly notched. Male plates longer than combined basal width, broad at base concavely narrowed on apical third to form blunt, pointed apices. Styles broad at base, concavely, abruptly, narrowed to form slender, pointed caudally directed apical third. Oedagus in ventral view with a pair of long processes arising near base slightly constricted at about one-third their length, beyond which they are broadened and gradually tapered to long slender pointed apices. These two processes cross so that the apical fourth is directed laterally. Dorsal process in lateral view with

[1]Amer. Mid. Naturalist. 17: 965, November, 1936.

apical portion rather long, curved caudally, apex blunt, rounded, a slight tooth on dorsal edge.

Described from one male and three female specimens collected at Loyalsock, Pa., August 12, 1918, by J. G. Sanders; one male, Cedar Run, Pa., July 12, 1920, J. N. Knull; one female, Port Trevoiton, July 26, 1918, J. G. Sanders. Holotype male and allotype female (Loyalsock, Pa.) and male and female paratypes in collection of senior author.

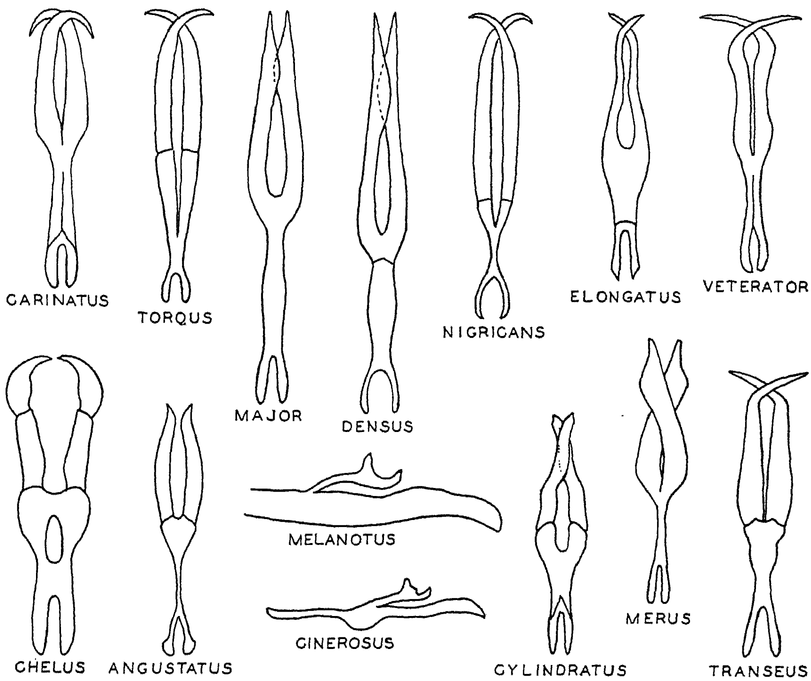

FIG. 1. Ventral views of male oedagi as labeled except in cases of melanotus and cinerosus which are lateral views.

This species differs from *transeus* in having more bluntly pointed plates and by having a dorsally produced portion on the connective. It differs from *frisoni* which has a more constricted portion in oedagus, blunter pointed plates, longer slender curved tips of styles and a tooth on lower caudal portion of pygofer.

Scaphoideus angustatus n. sp.

Resembling *frisoni* in form and appearance but with distinct genitalia. Length, 6 mm.

Vertex strongly produced and bluntly angled, a little wider between eyes at base than median length.

Color: Face pale with two heavy arcs above. The general coloration is essentially like *veterator*. The transverse band on disc of vertex strongly produced anteriorly at middle. Elytra rather pale brown, veins darker.

Genitalia: Male plates not quite as long as combined width at base, broad at base, convexly rounded then narrowed to blunt, pointed apices. Styles abruptly narrowed at two-thirds their length to form long, narrow processes which are curved slightly outwardly. Oedagus in ventral view with a pair of long processes arising near base and extending caudally. These are dorso-ventrally flattened, curved inwardly at apices and are separated at middle. The pointed apices are formed by the curvature of the inner margin as it meets the outer margin. Dorsal process extending ventrally between the two ventral processes of oedagus.

Described from two male specimens collected in Pennsylvania. One was collected at Ohio Pyle, July 20, 1919 (D. M. DeLong); and the other at Speeceville, July 3, 1917, by J. G. Sanders. Holotype male, Speeceville, Pa., and paratype male in collection of senior author.

This species can be distinguished from *merus* which it most closely resembles by the more narrow processes of the oedagus, by having the plates more pointed at apex, the apices of styles more slender and straight, and the apical portion of the dorsal process more narrow and without a dorsal tooth at the apex.

Scaphoideus merus n. sp.

Resembling *carinatus* in size, form and general appearance, but with distinct genitalia. Length, 6.5–7 mm.

Vertex strongly produced, apex bluntly angled, almost as long at middle as basal width between the eyes.

Color: Face pale with two heavy dark bands below margin of vertex. Marginal line above, broken at middle and widened either side at apex. Median transverse band on vertex decidedly notched either side of central anterior produced portion, causing it to appear trilobate anteriorly. Pronotum and scutellum dark brown, mottled. Elytra white, washed with pale brown, veins, margin at apex and a spot on center of clavus dark brown.

Genitalia: Female last ventral segment with prominent lateral angles, posterior margin almost truncate, slightly emarginate either side of middle and black margined. Male plates short and broad, length equalling combined basal width, convexly rounded to form blunt apices, styles abruptly narrowed at two-thirds their length to form narrow processes which are bent strongly outwardly and produced. Oedagus in ventral view with a pair of short broad, flat processes arising near the base, curved so as to leave an opening between them at base but overlapping at apex. The inner margin curves and slopes to outer margin so as to form a pointed apex. Dorsal process with the apical portion rather broad, rounded at apex and with a dorsal pointed tooth.

Described from a series of four female and seven male specimens collected at Washington, D. C., July 3, 1919, (Sanders); two females, Ohio Pyle, Penna., July 19, 1919, (DeLong); one female, Charter Oak,

Penna., (Kirk and Champlain); one male, Port Trevoiton, Penna., July 26, 1918, (Sanders); one male, N. Bloomfield, Penna., July 26, 1920, (Sanders); one male, Richfield, Penna., July 16, 1918, (Sanders); one male, Chambersburg, Penna., June 14, (Knull).

Holotype male, allotype female (Washington, D. C.) and male and female paratypes in collection of senior author. Male and female paratype in Illinois Natural History Survey Collection, Urbana, Illinois.

Scaphoideus torqus n. sp.

Resembling *major* in general appearance, but with distinct genitalia. Length, 6.5 mm.

Vertex strongly angled, apex blunt, almost as long at middle as basal width between eyes.

Color: Face pale brownish with at least three heavy brown arcs above. Brown line below vertex margin heavy, the one above more narrow and interrupted at middle. Vertex pale, band on disc rather narrow and slightly produced anteriorly at middle. Pronotum and scutellum tawny. Elytra pale, veins brown, darker on posterior half.

Genitalia: Male plates about as long as combined basal width tapered to bluntly pointed apices. Basal two-thirds of styles broad, apices narrow, long and gently curving outwardly at tips. Oedagus in ventral view composed of two portions which are separated at base but curve inwardly and cross anterior to the apices which are directed laterally. The dorsal process with apical portion tapered, bluntly pointed and not bearing a dorsal tooth. The upper apical portion of pygofer with a distinct tooth which will readily separate this species from those closely related.

Described from three male specimens, one collected at North East, Pa., July 30, 1919, (D. M. DeLong); one at Harrisburg, Pa., July 7, 1918, (J. G. Sanders); one at Castle Rock, Grand Detour, Ill., July 2, 1932, (Dozier and Mohr). Holotype male, North East, Pa., and male paratype in collection of senior author. Male paratype in State Natural History Survey Collection, Urbana, Illinois.

Scaphoideus elongatus n. sp.

Resembling *cirrus* in form and appearance but with distinct genitalia. Length, 6.5–7 mm.

Vertex strongly angled, apex blunt, slightly wider between eyes at base than median length.

Color: Face pale, slightly smoky with dark arcs above. A slender black line just beneath margin of vertex, the one above a little broader either side of median line where it is broken. Median transverse band on disc of vertex rather narrow, tawny and strongly produced anteriorly at middle. Pronotum and scutellum brownish mottled with white. Apical half of scutellum paler. Elytra white, veins dark brown, fuscous blotches forming an indefinite oblique band from anterior claval area to median costal area. Apices smoky.

Genitalia: Female last ventral segment almost truncate, slightly produced, and slightly concavely rounded at middle. Male plates

longer than combined width at base, gradually narrowed to pointed apices. Styles very broad at base, abruptly narrowed at about half their length to form long slightly curved tapering apices. Oedagus in ventral view composed of a pair of processes which taper to pointed apices and which overlap. These are curved so as to be contiguous at middle and be separated anterior to and posterior to this point. The pygofer is unusually long and pointed. This alone will separate the species from all others except *chelus*, which has a very different oedagus.

Described from two male and one female specimens collected at Waynesburg, Pa., July 16, 1919, by the senior author; and four female specimens, one each from Anacostia, D. C., August 22, 1905, (J. G. Sanders); Chain Bridge, Va., August 13, 1905, (J. G. Sanders); Greenfield, Pa., August 28, 1920, (D. M. DeLong); Tupelo, Miss., July 1, 1921, (C. J. Drake); and Starved Rock, Illinois, July 14, 1932, (Dozier and Park). Male holotype, female allotype (Waynesburg, Pa.) and male and female paratypes in collection of senior author. Male paratype is in State Natural History Survey collection, Urbana, Illinois.

Scaphoideus cylindratus n. sp.

Resembling *frisoni* in general appearance but with blunter head, darker color and distinct genitalia. Length, 6–6.5 mm.

Vertex rather strongly angled, blunt at apex, about as long at middle as basal width between eyes.

Color: Face pale brown with broken arcs and two continuous dark lines beneath margin of vertex. Marginal line above slightly broken at middle. Vertex pale, transverse band on vertex narrow, slightly produced at middle and pale orange in color. Pronotum uniform brown, scutellum paler with basal angles dark. Elytra rather uniform dull brown in color with veins and apex darker but almost devoid of areolar markings.

Genitalia: Female last ventral segment broadly roundedly produced and black margined on central half. Male plates almost one-third longer than combined width at base, convexly rounded and tapered to pointed apices. Apical third of styles composed of long, slender, tapering processes. Oedagus in ventral view composed of a pair of rather short, broad cylindrical processes which are bluntly pointed and slightly curved upwards at apex. Dorsal process rather long, apical portion slender and tapered to blunt tip.

Described from a series of six female and one male specimens collected at Kane, Pa., August 18, 1921, and 22, 1919, (D. M. DeLong); male, Loyalsock, Pa., August 2, 1918, (J. G. Sanders); male, Ft. Kent, Maine, August 28, 1910, (Herbert Osborn); Ithaca, N. Y., August 1, 1905; Urbana, Ill., July 2, 1920, (C. P. Alexander). Holotype male, Loyalsock, Pa., allotype female, Kane, Pa., and male and female paratypes in senior author's collection. Paratype male (Urbana, Ill.), Illinois State Natural History Survey collection, Urbana, Illinois.

Scaphoideus chelus n. sp.

Resembling *major* in form and general appearance but darker and with distinct genitalia. Length, 6–7 mm.

Vertex rather sharply angled, median length equalling basal width between eyes.

Color: Face slightly tawny with one broad and several narrow arcs above. A dark line just below vertex and a slender one above, broken at middle. Vertex pale with a rather broad and somewhat poorly defined transverse band between eyes, tawny. Pronotum and scutellum brown, the former with a paler indistinct band. Elytra brownish, veins dark brown.

Genitalia: Female last ventral segment with prominent angles, posterior margin slightly produced to form a median rounded lobe which is slightly emarginate at apex. Male plates rather short and broad, a little longer than combined basal width, convexly rounded to blunt apices. Styles with apical third narrow, tapering to pointed apex and curved slightly outwardly. Oedagus in ventral view with a pair of separated processes arising from basal portion which extend caudally and bear at their apices a pair of curved, broad, pincher-like processes which taper to sharp pointed proximal apices. Dorsal process with a rather long tapering apical process which curves slightly upward and is bluntly pointed at apex.

Described from a male and two female specimens collected at Dolson (Rocky Branch) Illinois, July 18, 1934, by H. H. Ross and the senior author, and one male specimen from Alton, Illinois, June 27, 1934, by the same collectors. Holotype male and allotype female (Dolson) in State Natural History Survey collection, Urbana, Illinois. Male and female paratype in collection of senior author.

Scaphoideus transeus n. sp.

Resembling *major* in form and general appearance but with distinct genitalia. Length, 5.5 mm.

Vertex strongly produced and bluntly angled, median length equaling basal width.

Color: Face pale, a narrow black line beneath the margin of vertex and a broader one ventral to this. Marginal line above broken at middle and broadened either side of apex. Vertex white, transverse median band orange at sides darker at middle and anteriorly produced. Pronotum and scutellum pale brown, veins, apex and spot on median costa dark brown.

Genitalia: Female last ventral segment with posterior margin slightly produced, median fourth with a rather broad, shallow notch. Male plates longer than combined basal width, narrowed almost from base to form long pointed tips with blunt apices. Apical half of styles narrow, tapered to pointed apices and almost straight. Oedagus in ventral view composed of a pair of processes which are broad and proximal at base and which diverge to apex of plates where they bend inwardly, cross and taper to long pointed apices. Dorsal process of oedagus with a rather long curved rather narrow apical portion.

Described from a male and female collected at Dolson, Illinois (Rocky Branch), July 18, 1934, (Ross and DeLong); one male, Galena, Illinois, July 10, 1934 (Ross and DeLong); one male, Ames, Iowa, June 22, 1896, (Herbert Osborn); one male, Washington, D. C., without date. Holotype male, Ames, Iowa, in Herbert Osborn collection. Allotype female and paratype males from Illinois in State Natural History Survey collection, Urbana, Illinois. Male paratype, Washington, D. C., in senior author's collection.

Scaphoideus densus n. sp.

Resembling *major* in form and general appearance but smaller and with distinct genitalia. Length, 6–6.5 mm.

Vertex strongly produced and angled, a little wider between eyes than median length.

Color: Face pale with three dark lines on upper portion. Marginal line on vertex broken at middle and broadened either side. Median band narrow, obliquely sloping to margin on either side and strongly produced at middle, tawny. Pronotum and scutellum brownish, elytra white, washed with pale brown, a spot on anterior clavus and apex of elytra dark brown.

Genitalia: Female last ventral segment slightly produced, rounded and broadly black margined. Male plates about as long as combined basal width, apical half sloping to bluntly pointed apices. Styles broad, convexly, roundedly constricted and notched at two-thirds their length forming rather long, outwardly curved, bluntly pointed apices. Oedagus more than one-third longer than connective, two branched, each arm broadened on inner margin one-third the distance from apex and tapered to a sharp pointed tip. In lateral view the oedagus is broadened near apex, curved and tapered to pointed tip. Dorsal process very broad at base with a short thick apical portion which is rounded at apex and bears a dorsal spine.

Described from a series of two male and two female specimens collected at Elizabethtown, Illinois, May 27, 1931, and June 25, 1932, by Ross, Dozier and Park; one male, Bluff Springs, Illinois, June 10, 1932, Ross and Mohr; one male, Eichorn, Illinois, June 13, 1934, Ross and DeLong; one male, Little Mt., Ohio, August 21, 1904, (Osborn collection); and one male, Rigaud, Quebec, August 4, J. O. Quellet.

Holotype male (Rigaud, Quebec) in author's collection. Allotype female and male and female paratypes in Illinois State Natural History Survey collection, Urbana, Illinois. Paratype male in Herbert Osborn collection.

Scaphoideus cinerosus Osborn

Scaphoideus cinerosus Osborn. Jour. Cinc. Soc. Nat. Hist. 19: 208, 1900.

Male plates rather short, broadly rounded at apex. Styles broad at base, tapered to slender, outwardly bent and pointed apices. Oedagus in ventral view appearing two-branched with processes long, straight and tapered to pointed apices. In lateral view enlarged at about one-half its length then constricted with the apical third broadened apex

curved on dorsal portion to a ventral sharp pointed tip. Dorsal process arising from enlarged process at middle, expanded at apex with a blunt rounded anterior process, a curved finger process caudally and a median dorsal tooth.

Allotype male, Granville, Ohio, July 25, 1928, in Herbert Osborn collection.

Scaphoideus nigricans Osborn

Scaphoideus nigricans Osborn. Ohio Nat. 11: 258, 1910.

Male plates as long as combined basal width, tapered from base to bluntly pointed apices. Styles long, concavely narrowed at about one-third their length and again near the apex so that the terminal fourth is produced into a slender curved finger-like process. Oedagus two-branched, processes long, curved inwardly, crossed near apex and tapered to pointed tips. In lateral view with processes curved upwardly and anteriorly at apex. The dorsal process long, broad at base, rather abruptly narrowed and produced into a long, caudally directed, bluntly pointed process.

Allotype male, Black Mt., N. C., June, in Herbert Osborn collection, Ohio State University.

Scaphoideus melanotus Osborn

Scaphoideus melanotus Osborn. Jour. Cinc. Soc. Nat. Hist. 19:206, 1900.

Male plates one-fourth longer than combined basal width, scarcely narrowed toward apices which are broadly rounded. Styles suddenly narrowed, apical fourth long, slender, strongly curved outwardly. Oedagus in lateral view broad, apex broadly, bluntly rounded. Dorsal process rather slender at base, broader apically, forming two short divergent processes. Pygofers with a pair of spines at apex which are large and turned inwardly.

Allotype male, Ames, Iowa, 7–30–96, in Herbert Osborn collection, Ohio State University.

Scaphoideus productus Osborn

Scaphoideus productus Osborn. Jour. Cinc. Soc. Nat. Hist. 19:200, 1900.

In the Osborn collection is a series of four cotypes, all females, two of which are undoubtedly the same species and have the strongly produced female segment described by Professor Osborn in the original description. Since it seems necessary to choose a lectotype at this time the specimen labeled "Experiment Station, Ames, Iowa, Aug. 7, 97" is designated. It has been impossible to choose a male allotype because all those which are similar in form and color have been definitely associated with female specimens which do not have the strongly produced segment.

Scaphoideus major Osborn

Scaphoideus immistus var. *major* Osborn, Jour. Cinc. Soc. Nat. Hist., 19:205, 1900.

The type of this species described by Professor Osborn is labeled "Ames, Iowa, 7–30–96." The male allotype is labeled "Ames, Iowa,

6-27-96." Both are in the Osborn collection. The internal genitalia have not been described.

Male plates not quite as long as combined basal width strongly convexly rounded to bluntly pointed apices. Styles tapered from base, strongly and suddenly narrowed on outer margin so that the apical fifth is a short outwardly curved finger-like process. Oedagus about the length of the connective, two-branched, in ventral view appearing broadened on inner margins about one-third the distance from apex and tapered to pointed tips. In lateral view the oedagus is tapered to a long attenuated pointed apex. Dorsal process semicircular, tapered to apex which is blunt, slightly enlarged and with a very small dorsal spine.

Scaphoideus carinatus Osborn

Scaphoideus carinatus Osborn. Jour. Cinc. Soc. Nat. Hist. 19:201, 1900.

Two female cotypes are in the Osborn collection. The specimen labeled Hanover, N. H., C. M. Weed is designated as the lectotype. A series of five female and one male specimens are in the Osborn collection labeled Little Mt., Ohio, Aug. 21, 1904. These are females agreeing exactly with the type and the corresponding male is here described and designated as the allotype.

Male plates about as long as combined width at base, sloping gradually from base to near apices where they are abruptly narrowed on outer margins, then produced to sharp pointed apices. Inner margins of plates curved outwardly at apex. Styles broad at base, abruptly narrowed near apex to form short finger-like processes which are curved outwardly at apices. Connectives long, reaching two-thirds the length of plates and with dorsal structures which are broad and vertical. Oedagus in ventral view two-branched, processes short and thick, usually crossed and curving caudally and dorsally into segment. The dorsal process is short and thick, usually lying in the concavity of the curved oedagus processes.

Allotype male, Little Mt., Ohio, Aug. 21, 1904, in Herbert Osborn collection, Ohio State University.

Biochemistry

This concise textbook on biochemistry is not offered as a substitute for, nor is it a condensation of, the author's well known textbook of Physiological Chemistry. It is written for the medical student who must cover the subject in a limited time and yet not miss any of the fundamentals. The text is based on the author's long teaching experience. It progresses logically and easily and gives a digest of established facts without going into speculative fields. The many structural formulae are clearly printed and some of the chapters dealing with broadly complex material are followed by summaries. Newer subject matter is given as from the particular worker in that field, but there is no compilation of a reference bibliography. The book has a good working index.—R. G. SCHOTT.

Principles of Biochemistry, by Albert P. Mathews. x+512 pp. Baltimore, William Wood and Co., 1936. $4.50.

STUDIES IN THE BIOLOGY OF THE LEECH. IV

An Explanation of Certain Phases of Leech Behavior

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In the study of natural phenomena man is confronted with a three-fold problem. First, what occurs; second, how does it occur; third, how can one account for its occurrence. In answering the first two of these questions it is only necessary to make careful observations and to give accurate descriptions of the phenomena. The solution to the third, however, enjoys the distinction of being the product of careful analysis of causal factors and the application of established principles. The study of animal behavior not only involves an analysis of the action systems and the responses of the organism, but it demands a physical explanation of these responses.

I regard the knowledge of the nervous and muscular systems essential to an understanding and explanation of the behavior of any animal. Each species has its characteristic mode of reaction to changes in its environment. Its behavior is determined primarily by the nature of the behavior pattern which is a recognized part of its inherited organization. The morphology of the nervous and muscular system of the leech *Haemopis marmoratis* has been previously described, so that for the purposes of this paper we do not need to deal with it further.

Through a knowledge of the nervous and muscular system, and through the treatment of this behavior pattern as a basis, we are able to describe and explain certain phases of leech (*Haemopis marmoratis* (Say)) behavior. It is the object of this paper to interpret certain characteristic movements in terms of the stimuli and the intrinsic behavior patterns.

DISCUSSION OF RESPONSES TO ELECTRICAL STIMULATION

The behavior of an animal consists of acts which are the ultimate effects of stimuli upon its particular type of anatomical structures. These stimuli originate either from the environmental forces of the outer world or from causes operating within the body of the animal. The usual reactions to external stimuli are movements.

As described in preceding publications (Miller, '33–'34) there are distinct differences in behavior when the leech is subjected to different stimuli. These differences in behavior are due to the contraction of different combinations of body wall muscles. These muscles contract only upon stimulation. Direct current of low voltage stimulates motor neurons directly. (Loeb, Lillie, Shensa and Barrows).

Shensa and Barrows (1932) applied the "Law of Polar Stimulation," Lillie (1923) to the neurons of the subepidermal nerve plexus in the earthworm. In so doing they explained the behavior of the worm to lateral electrical stimulation.

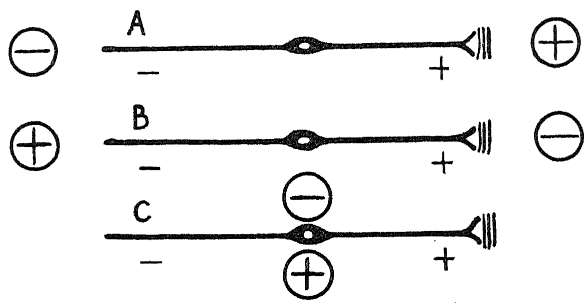

FIG. 1

FIG. 1. Diagram illustrating the arrangement of electrodes in relation to the nerve cells and muscles. The electrodes are shown inside circles. A, the current direction which causes muscular contraction; B, the current direction which causes muscular relaxation; C, the current direction which does not affect the polarity of the neuron.

Experimental evidence, obtained by the author, demonstrates the same polarity of motor neurons in the leech. The references to galvanotropic responses on the part of some of the Annelida is to be found in the literature. The use, however, of this law or principle directed to a better understanding of the minute nervous structure and behavior of the leech has not previously appeared in the literature.

ANTERIOR POSTERIOR STIMULATION

Figure 1 illustrates neuron polarity and the effect upon the muscle of electrodes placed in a variety of relations to the neuron. It has been previously stated (Miller, '34) that when the negative electrode is placed in front of the anterior end of the leech and the positive electrode behind the posterior end, the leech elongates and crawls toward the cathode. With the

poles reversed, from the above stated situation, the leech shortens and eventually orients itself by turning completely around and crawls toward the cathode.

The only reasonable explanation of this orientation is found in the application of the principle of neuron polarity to a system in which certain neurons extend parallel to the current of negative electrons when the electrodes are placed as described

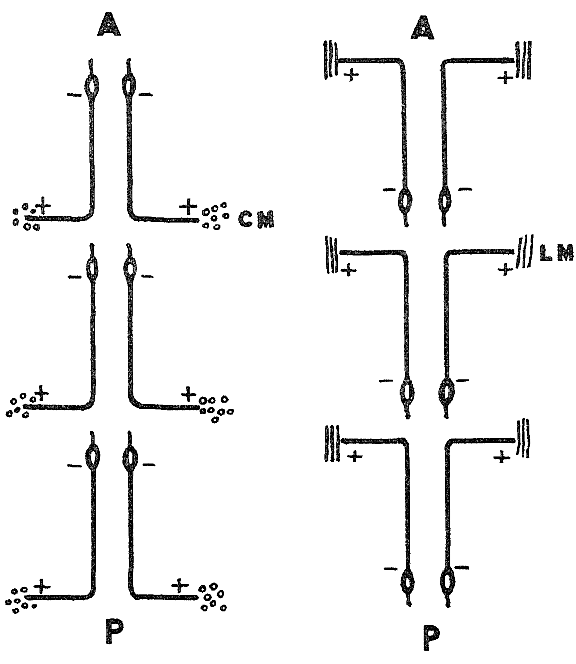

FIG. 2 FIG. 3

FIGS. 2 and 3 illustrate the polarity of motor neurons within the ventral nerve cord and their relation to the body wall muscles. A, anterior; P, posterior; C. M., circular muscles; L. M., longitudinal muscles.

above. The impulses instigated by the current travel directly over the neurons in the cord. Herein lies the experimental proof of the position of the motor neurons within the cord. (See Figs. 2, 3.)

Figure 2 illustrates the position of that group of motor neurons within the cord which innervate circular muscles. This group of neurons have their origin and highest region of gradient anteriorly. The placing of the negative electrode near

the anterior end brings about a contraction of the circular muscles. As a result of this contraction the leech elongates. This elongation is easily seen and facilitates forward locomotion. The influence of the positive electrode at the posterior end has an inhibitory effect on the longitudinal muscles. This makes shortening difficult and to some extent delays forward locomotion.

With the negative electrode near the posterior end the impulses so incited are conducted over neurons innervating the longitudinal muscles. The current running lengthwise through the longitudinal muscles as well as the neurons probably intensifies the contraction. The contraction of these muscles (longitudinal) results in a shortening of the leech. The contraction of the circular muscles is inhibited by the action of the positive electrode at the anterior end. (The turning toward the negative electrodes is explained below.)

This electrotactic response on the part of the leech can now be explained entirely on a cause and effect basis. Locomotion, by reptation, is the result of co-ordinated contractions of circular and longitudinal muscles. The contraction of these muscles is intensified or inhibited as a result of the increase in polarity of the motor neurons innervating them.

LATERAL STIMULATION

To understand the behavior of the leech when the electrodes are placed a few inches to the right and left of the mid-body region involves an understanding of the subepidermal nerve plexus.

Until recently this system was not taken into account in explaining Annelid behavior. Following the description of this system in the earthworm by Hess (1925), Shensa and Barrows (1932), applied it to the explanation of certain phases of earthworm behavior. The subepidermal nerve plexus of the leech was described by the author in 1933, making possible this explanation of leech behavior to lateral electrical stimulation.

Experiments conducted by Miller (1934) demonstrate that the longitudinal muscles on the side facing the negative electrode are stimulated directly through the motor neurons in the subepidermal plexus. The motor neurons of this plexus lie at right angles to the surface of the skin. These neurons are polarized in such a way that the longitudinal muscles on the negative are stimulated while those on the positive side are

relaxed or inhibited. Stimulation in this manner results in the leech assuming a position like that of a "C," with the anterior and posterior ends toward the negative. Prolonged stimulation in this manner results in the extension of the anterior end toward the negative electrode but does not cause the posterior end to elongate. This elongation and movement of the anterior end is explained in a preceding paragraph.

DORSAL VENTRAL STIMULATION

In response to dorso-ventral electrical stimulation the leech orients itself in the following manner. The anterior and posterior ends point toward the negative, the middle region contracts and the dorsal surface orients toward the negative. (For details see Miller, 1934.)

The negative current stimulates the longitudinal muscles through the subepidermal nerve plexus on the surface facing this electrode. This results in the leech assuming a "U" shaped position pointing the anterior and posterior ends toward the negative electrode. In this position the anterior end elongates. This elongation is the result of circular muscle contraction. The circular muscles are stimulated through impulses conducted by motor fibres in the ventral nerve cord. These neurons, as in preceding experiments, are directly influenced by the polarized field in which they lie.

The orientation of the dorsal surface toward the negative electrode is, in my opinion, a combined neuro-motor and mechanical response. The fact that the ventral series of longitudinal muscles is much stronger than the dorsal series results in a higher arching of the animal when the negative electrode is below than when the negative electrode is above. As a result of this high arching the animal rolls over bringing the dorsal surface next to the negative electrode. In the latter position the dorsal longitudinal muscles contract. The contraction of these muscles does not bring about sufficient arching to cause the animal to roll over. Hence, the animal remains oriented with the dorsal surface toward the negative electrode.

SUMMARY AND CONCLUSIONS

To complete a study of animal behavior the physical explanation of the responses of the organism is necessary. To be able to do this it is imperative that the nervous and muscular systems be well understood. Direct current of low

voltage acts as an excellent source of stimulation. Our knowledge of the polarity of motor neurons makes it possible to interpret the contraction of certain muscles as a result of the increase in polarity of the neurons innervating them. This not only reduces the understanding of behavior to cause and effect but makes possible a better understanding of the exact arrangement of the minute motor neurons within the cord, and the principles which apply to this type of behavior study.

1. The leech has a specific neuro-muscular pattern; this mechanism can be stimulated directly; the behavior of this organism is understandable (as far as these experiments permit) as the joint product of the stimulus and the reaction pattern.
2. Different expressions of behavior are due to the ultimate effects of stimuli upon different combinations of body wall muscles.
3. The behavior pattern of an organism is a recognized part of its inherited organization.
4. Animal behavior is the ultimate result of stimuli upon a particular arrangement of anatomical structures.
5. Experimental evidence obtained here demonstrates for the leech the same polarity of motor neurons as previously demonstrated for other organisms.
6. The electrotactic responses of the leech can now be explained entirely on a cause and effect basis.
7. There is an understandable physical explanation of animal behavior that becomes apparent upon the analysis of the action systems of the organism.
8. Whereas all animals may not lend themselves to behavior studies, there are forms, such as the leech, from which certain of the fundamental principles of behavior may be derived.

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BOOK NOTICES

Metropolitan Geology

It is always of much interest to find the geology of a metropolitan area taken up and discussed before the growth of the area and the destruction, accidental or otherwise, of old records makes it impossible. The author in dealing with the geology of the Minneapolis-St. Paul metropolitan area gives us first a chronological list of publications relating to the geology. The earliest is dated 1872, the last 1935. The geography of the area is discussed by Richard Hartshorne and the vegetation by F. K. Butters. The geology begins in Chapter three, where we find the section ranges from the Red Clastic Series of the Pre-Cambrian to the Galena of the Ordovician. The formations from the Galena to the Pleistocene are absent. Of the Pleistocene there are recognized six drift sheets, it being understood that these represent various lobe advances and not necessarily new advances following interglacial periods. The various drainage changes are discussed, followed by a series of short summaries by eras. The structure is taken up in Chapter four and is shown to be, in general, a main basin, the Twin City Basin. The economic products are listed as water, stone, sand, gravel, foundry sands, clays, shales, peat, and marls. None of these except water and sand are of considerable economic importance. The rest of the book is a tabulation of data on the area.

Dr. Schwartz has produced a very useful book, both for the geologist and the engineer. The area, situated as it is, is of considerable interest and well deserves the careful work represented by this publication. The 46 figures are well chosen. The 7 plates consist of two cross-sections and five maps, one a colored geologic map on a scale of 1 over 96000. We compliment both the author and the publisher of this useful and valuable book.—WILLARD BERRY.

The Geology of the Minneapolis-St. Paul Metropolitan Area, by George M. Schwartz. Minnesota Geological Survey Bulletin 27. xi+267 pp. Minneapolis, University of Minnesota Press, 1936. $3.50.

Physics for the Layman

The bibliographer of the Bell Telephone Laboratories has extended his Lowell Institute lectures of the fall of 1935 and published them as a popular non-mathematical treatise on physics. The language has been kept extremely simple, and technical terms are introduced only after a very careful analysis of their meanings in everyday language. The facile handling of the subject is characteristic of all the author's works.

The first third of the book deals with an historical development of physics up to the opening of the nineteenth century, showing the gradual rise of the subject from "natural philosophy" to a science based on experiment. This exposition, together with the extension of a few of the subjects discussed in the first section, serve as a fitting introduction to the main thesis of the book, the transmutation of the elements, which occupies the final third of the work.

The book is carefully written in general, but we are startled to note that the New Deal has been active in the physical world, for on page 75 the acceleration of gravity has been devalued to approximately 50% of its generally accepted value! The volume is printed in very legible type, and well bound. Numerous figures and photographs help the reader in understanding the text.—J. B. GREEN.

The Renaissance of Physics, by Karl K. Darrow. 306 pp. New York, The Macmillan Co., 1936. $3.00.

Ecology of Insects

The other editions of this well known text and reference book in entomology have had a definite place in entomological development in the United States and Canada. Because of their lacking the recent advances in our knowledge of entomology, the third edition has been completely revised by Professor Wardle. He has added many new and recent advances to our knowledge of insects without changing the basic structure of the book in its previous editions. The main

additions have been made to the chapters dealing with Insects and Man and Insects and Disease, although a great deal of information has been added to the other chapters. Many new references have been added and some of the old ones deleted.

The revision returns this book to the preferred list of entomological texts. It is not economic in nature but stresses many interesting facts about insects which do not appear in other textbooks of the subject. The author does not stress insect classification.—R. H. DAVIDSON.

Entomology With Special Reference to its Ecological Aspects, Fourth Edition, by Folsom, J. W. and Wardle, R. A. 605 pp., 308 figs., and 5 plates. Philadelphia, P. Blakiston's Son & Co., Inc., 1936.

Electricity Without Mathematics

It is very refreshing, in these days, when almost anyone sets himself up as an interpreter of recent scientific experiments and their philosophical import, to find a book about homely electricity written by a physicist of unquestioned standing and attainment, a Nobel Laureate.

The book is a treatment of electricity such as might be given to the ordinary high school student, and indeed, is written so that such a student may readily understand it. Only the principles of electricity and the laws governing its generation and flow and interactions are discussed, with no attempt to study quantitative relationships. The material in the volume is taken from a series of six lectures given by the author at the Royal Institution (where Faraday's Laboratory was located) primarily for a "juvenile auditory" (the type of audience is seen on the frontispiece) and is well illustrated by a large number of carefully constructed diagrams and photographs.

It is the author's aim to put the fundamentals of electricity on such a simple basis, that a "sense" for it is developed to enable the reader to grasp easily the workings of everyday household electrical equipment; in much the same way that our mechanical sense has been developed by contact with mechanical equipment. I think that this is a habit of thinking which will take a generation to develop, for all our teachers at present have been brought up to think "mechanically" rather than "electrically" and we must wait for a new generation of teachers brought up in "electrical" surroundings before the author's aim is realized.

—J. B. GREEN.

Electricity, by W. L. Bragg. xvi+272 pp. New York, The Macmillan Co., 1936. $4.00.

Star Families in Space

Man has in effect looked at his universe three times. At first he saw it as a solar system accompanied by stars. Second, he saw it as a universe of stars with his solar system an insignificant part. A third glance has revealed it as a universe of star families scattered rather uniformly throughout space. These families are known as extra-galactic nebulae because they are objects outside of our own family or galaxy. They appear as elliptical bodies, spiral systems and barred objects. The light of the brighter and closer ones is normal, but the farther away they are the redder they appear. This effect has been interpreted to mean that all the extra-galactic nebulae are receding from each other with velocities which are proportional to their distances from each other. On this interpretation is based the idea of the expanding universe. Whether or not the interpretation is the correct one is another matter for the problem is by no means settled. Author Hubble is one of the outstanding contributors to knowledge of the nebulae and it is unfortunate that his carefully written book has been done in so pedantic a style. It is a well compiled collection of facts and ideas but lacks the vital, compelling style that such a book should have when its author has a story of his own to tell. An effort is made to present the subject matter in a semi-popular way, but in the opinion of the reviewer this has been a failure. The past tense is used throughout, and the point of view is that of the historical summarizer. The subject matter is frequently repetitious. These characteristics unfortunately have the effect of detaching the reader so that he is unlikely to see the subject intimately with the writer. This book might have been one of the finest popular accounts of contemporary science.—C. E. HESTHAL.

The Realm of the Nebulae, by Edwin Hubble. xii+207 pp. New Haven, The Yale University Press, 1936. $3.00.

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